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Electric Melting Shows Economy

Yellow Brass Losses in the Electric Furnace are so Low That the Saving More Than Offsets Other Increased Costs of the Process— Crucible Losses are Cut in Half

ABOUT 10 years ago the commercial possibilities of the electric furnace were first advanced in this country, although previously it had been used to some extent in Europe. At that time the induction furnace and the arc type furnace both seemed promising for steel making uses and perhaps were equally favored by experimenters. As more experience was secured with electric furnace steel melting, the arc type attained predominance over the induction type furnace. With increasing knowledge of furnace requirements and working conditions improvements in design were constantly made until now the electric furnace has reached a fairly stable state in steel making. The situation in nonferrous foundries is different. In melting alloys of nonferrous metals the electric arc produces too high a temperature and volatilizes the metal if brought in contact with the bath as in the electric furnace for steel melting. Probably, for this reason, melting nonferrous metals offered more difficulties to the inventor, or possibly the inducements for melting nonferrous alloys in the electric furnace were not as strong as for melting steel, for the development of the electric furnace in the nonferrous field has been considerably slower. However, in the past few years several furnaces for melting the more volatile metals have been invented and have proved to be commercially successful.

One of these furnaces, made by the Electric Furnace Co., Alliance, O., was installed in the brass foundry of the Hays Mfg. Co., Erie, Pa., and the first heat was taken off on Oct. 30, 1917. Since that time quite a few points about the operation of the furnace have been learned by experience and a few minor changes in design have been made by the furnace manufacturers, so that now the Hays company has a melting medium for yellow brass that is giving entire satisfaction.

A view of the rear of this furnace is shown in Fig. 1. The electric current is brought from the power station at 6600 volts and reduced to 120 volts by a transformer located immediately back of the switchboard in a separate room. On the switchboard there is an indicating wattmeter which shows the power consumed at the time of reading, while a watthour meter keeps a record of the total watts consumed. These meters may be seen at *E* in the illustration. The amount of current used is regulated by a switch, the handle of which is indicated at *A*, Fig. 1. This is moved along the line and each successive notch connects another set of coils in the transformer

FIG. 1—THE CURRENT WHICH ENTERS THE FURNACE THROUGH THE ELECTRODE *B* IS CONTROLLED BY A SWITCH THE HANDLE OF WHICH IS SHOWN AT *A*

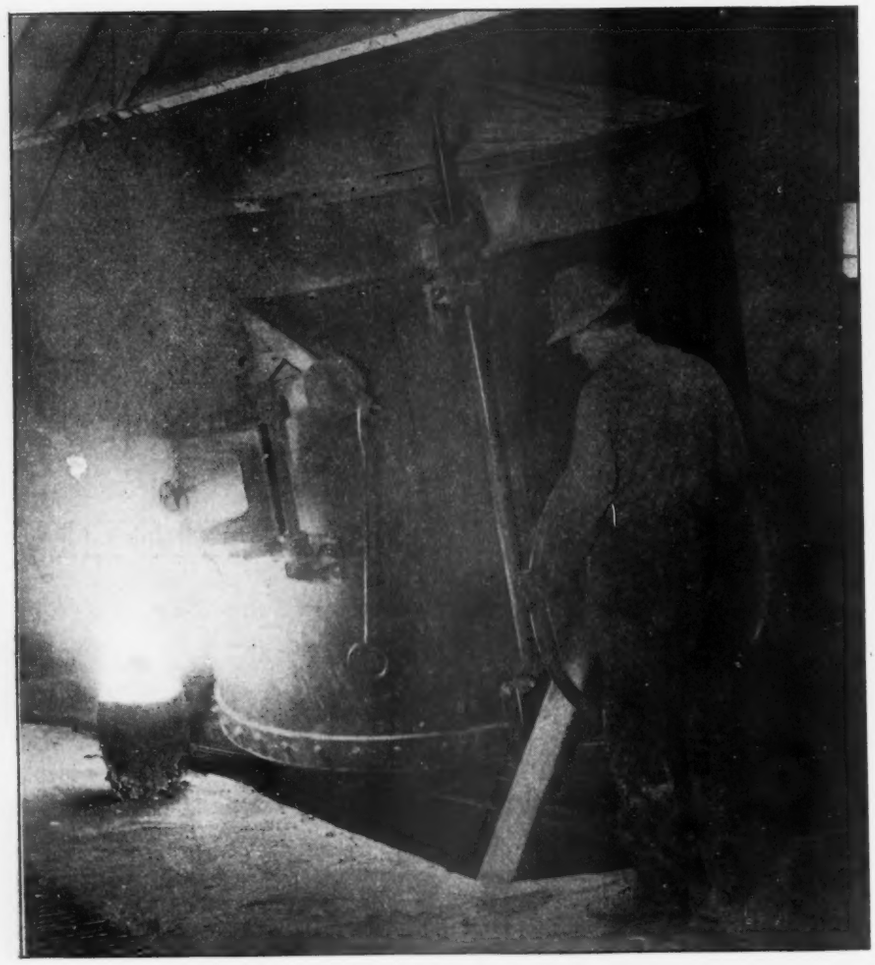


FIG. 2—METAL IS POURED FROM THE ELECTRIC FURNACE INTO HEATED POURING CRUCIBLES

and thus raises the current passing through the line. When the switch is at the lowest notch approximately 20 kilowatts pass through the circuit while as much as 150 kilowatts may be used when the switch is at the ninth, or last notch. The amount of power thus may be controlled to give the range of heat desired. From the switch, the current is conducted through copper cables to two graphite electrodes. One of these electrodes is shown at *B*, Fig. 1. The other electrode is similarly situated in the furnace, directly opposite to the one shown. These electrodes extend into a circu[illegible] carborundum trough which is filled with granular carbon. As the two electrodes are at opposite sides of the trough the current is carried from one electrode to the other through two paths, one going to the right and one to the left half way around the circle.

Heat is produced by resistance offered to the electric current by the granular carbon in the trough. This heat is radiated to the roof and from there to the metal bath, thus preventing local overheating, as would be the case were an electric arc to play directly on the bath. The resistance of the line increases as the carbon is slowly oxidized and so decreased in bulk. This would tend to cut down the current and so decrease the heating power of the furnace, but the regulation afforded through the switch previously described, takes care

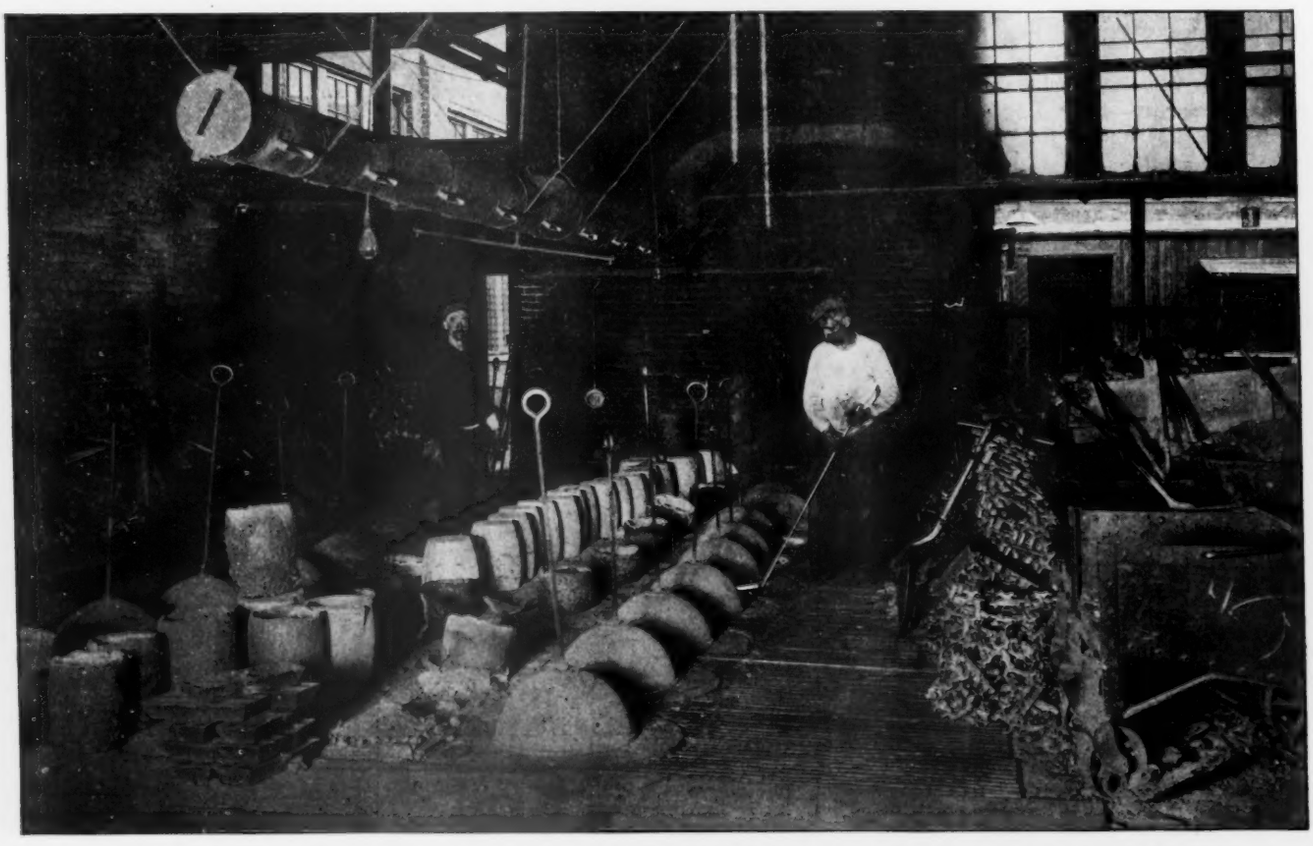


FIG. 3—RED BRASS MELTED IN CRUCIBLES—A SIMILAR CRUCIBLE FURNACE WAS FORMERLY USED TO MELT YELLOW BRASS

of this tendency up to a certain point. It has been found advisable to replenish the carbon in the trough after the furnace has been operated three weeks. To do this the top of the furnace is raised by turning the wheel, *C*, Fig. 1. This revolves the steel shaft directly above it and two others equally spaced about the circumference of the furnace. The latter two are actuated through a chain drive, part of which may be seen aside of the wheel. The roof of the furnace is attached to the screws on the ends of the shafts and so raised or lowered by revolving the shafts.

Replacing Resistance Material

The trough wears out entirely in time and must be replaced. When this is done, a new bottom is also made. As more has been learned about taking care of the furnace the life of the trough has been gradually lengthened. The last trough installed has been operated for more than six months and gives promise of lasting some time longer. The furnace is tilted by operating the hand wheel, *D*, Fig. 1, which can be easily turned by one man.

To heat the furnace, for melting on Monday morning, after having been idle since Saturday forenoon, the current is started at 11 o'clock Sunday evening. On the weeks when carbon is added to the resistor the furnace becomes so cool that it is necessary to start the heating current at 8 p. m. Sunday evening. On other days heating is started at 3:30 in the morning. At 6 o'clock a workman begins to charge metal which is brought to the furnace on trucks and shovelled in through the small door in the front. The first heat is poured at 8:15 and three more heats are taken off during the day, the last one coming out by 3:30 in the afternoon.

FIG. 5—NAILS RECOVERED FROM CORES ARE EASILY SEPARATED BY A MACHINE DESIGNED BY H. H. CLEMENS, TREASURER OF THE COMPANY

Twenty crucible pits, formerly used for melting yellow brass are directly in front of the furnace. Seven of these now are employed to heat crucibles to receive metal from the electric furnace. The crucibles are taken out of the pit furnaces and subsequently handled with tongs in the usual way. After the metal is poured into them they are taken to the molding floor over a monorail on which is a hand propelled buggy. These crucibles have twice the life of crucibles in which the metal is melted in a pit furnace. They are not discarded because they get weak and break through, as crucibles do after 18 heats in the pit furnace, but because the interiors become so filled with zinc oxide scale and crust as to seriously reduce their capacity and make them cumbersome to handle. Clay-lined iron ladles were tried in place of crucibles, but they did not prove satisfactory because a way was not found to get the interiors hot enough to retain sufficient heat in the metal to pour the light work into which it is cast, and molds poured from the last metal in the ladles were frequently misrun.

FIG. 4—REVOLVING PLATFORMS SAVE LABOR FOR THE MOLDER AND BRING THE MOLDS TO THE METAL WHEN POURING

Heat Determination

The necessity of determining accurately the temperature of the furnace and metal was realized and an indicating pyrometer, made by the Thwing Instrument Co., Philadelphia, was installed. Two platinum-rhodium thermocouples are used in connection with the pyrometer. The one determines the temperature of the bath and the other the temperature of the roof. It has been found that the roof should be kept at 2400 to 2500 degrees Fahr., while the metal should be poured at 2200 degrees Fahr. The couples protrude beyond the lining into the furnace two inches, but although protected, first by a porcelain tube and then by another covering tube, they do not last more than two months. In trying to prolong the life of the

FIG. 6—IRON IS SEPARATED FROM SCRAP AS IT PASSES OVER A MAGNETIC SHOOT—ANOTHER MACHINE SEPARATES IRON FROM TURNINGS

thermocouples many different outer tubes were tried but none extended the life of the thermocouples above two months.

The electric furnace, in melting four heats a day of 1500 pounds each, replaces 10 crucible pits from each of which it was the custom to take off three 200-pound heats a day. More metal could be melted in the electric furnace should it be required. If operated until 5 o'clock in the evening instead of being shut down at 3 o'clock another heat could be taken off. Time also could be saved in charging which now requires approximately 25 minutes, but could be done in a much shorter time. This was demonstrated when a heat was charged in four minutes on a speed trial. The present weight of charge has proved the most satisfactory under existing conditions but as much as 1620 pounds of metal has been melted in one charge.

Critical Power Rate

The most satisfactory rate of power consumption on an average has been found to be 120 kilowatts. The use of more power shortens the life of the furnace roof and the resistor trough, while less power lengthens the time required to complete the heat. The melting record for September gives an idea of the power consumption per unit weight of metal. During this month 140,000 pounds of yellow brass were melted, using 40,032 kilowatt hours, or at the rate of 572 kilowatt hours per ton of metal, or 29 kilowatt hours per 100 pounds. The Hays company buys power at a price rate conditional on power factor, demand, price of coal, etc., so that the rate is not known until the end of the month. For this particular month the charge on the 40,032 kilowatt hours consumed was at the rate of 1.41 cents per kilowatt hour. With the tonnage melted, this means that it cost 40.6 cents for power alone to melt 100 pounds of yellow brass. This is higher than the fuel cost for melting in crucible furnaces, but there are other items of cost in favor of the electric furnace which make it cheaper to melt yellow brass in the electric furnace than in crucibles. The following tabulations give the cost details of the two methods of melting based on September prices and conditions.

CRUCIBLE FURNACES

Coke	.16
Crucibles	.23
Labor	.16
Metal loss of 8 cent zinc 5 per cent	.40
Upkeep	.01
Total cost of melting 100 pounds of metal	.96 cents

ELECTRIC FURNACES

Power at 1.41 cents per kilowatt-hour	.41
Crucibles for pouring	.12
Labor	.08
Metal loss of 8 cent zinc; 1 per cent	.08
Heating pouring crucibles	.04
Upkeep	.03
Total cost of melting 100 pounds of metal	.76 cents

Furnace Shows Saving

These figures show a net saving of 20 cents per 100 pounds of metal melted in favor of the electric furnace. An additional expense is saved but not included in the figures. This is made up in handling coke, sorting the metal spilled into the coke, reclaiming metal spilled into the ashes, and remelting the recovered metal. The exact amount of this expense has not been ascertained,

FIG. 7—THE CORE OVENS ARE OF THE DROP-DOOR TYPE AND THE CORES ARE PLACED IN THE OVENS ON PERFORATED CAST-IRON PLATES

as part of the metal is melted in crucibles and the general labor expense has not been segregated. Should the remaining pit furnaces be replaced by another electric furnace, the workman who breaks and wheels coke could be dispensed with, a second who now picks scrap from the ashes and chips metal from crucibles could be put on other work, and the time of a third man would be saved in the cleaning room. In addition to this saving of man power, practically all the operations and machinery of the reclaiming room, except one small water mill to wash the spillings from around the electric furnace and the pouring floors, could be eliminated.

As has been mentioned, the Hays company melts only yellow brass in the electric furnace. The red brass and other alloys are melted in crucible furnaces shown in Fig. 3. The yellow brass is composed of approximately, 75 per cent copper, 4 per cent lead, 1 per cent tin and 20 per cent zinc. This high percentage of volatile zinc accounts for the 5 per cent loss of metal when the yellow brass is melted in crucibles. The electric furnace, with its 1 per cent loss, effects a saving of 4 per cent of metal. On the other hand there is a loss of only 2 per cent of metal when red brass with its lower zinc content is melted in pit furnaces, and the electric furnace would probably not be able to reduce this more than half. This would effect a saving of only one pound in a hundred against four pounds in a hundred for yellow brass, or 8 cents against 32 cents, which would make the expense of melting red brass in the electric furnace higher than in the crucible furnace. However, notwithstanding the higher cost, it is the intention of the Hays company shortly to install another electric furnace and dispense with all crucible furnaces for melting, as there are benefits from electric furnace melting which do not show on the cost sheet. One of these benefits is the better conditions under which the melters on the electric furnace work, compared to the hot and heavy work of tending the fires of the crucible furnaces and lifting out the crucibles.

Beside the electric furnace there are several other noteworthy features about the plant of the Hays company. One of these is the battery of four circular mold carriers shown in Fig. 4. Each circular platform is used by one molder who, after making the mold places it on the mold carrier and give the platform a slight push to turn it ready to receive the next mold. The collar at the top of the post, to which tie rods supporting the platform are affixed, turns on ball bearings so that the platform may be easily revolved. One advantage of this system is that the molder does not have to carry the molds far nor stoop over to set them down. Another benefit is that the men pouring the molds can stand at one place while the molds are brought around to them as each mold is poured. Pouring crucibles are carried on the chain block on the I beam shown at the left in Fig. 4.

At the right of the illustration may be seen one of the water tanks used to blow

FIG. 8—HEAT IS SUPPLIED TO THE CORE OVENS FROM COKE FIRES SIX FEET BELOW THE BOTTOM OF THE OVEN—NATURAL DRAFT IS USED

the cores from the castings. After a molder pours five or six moulds he shakes them out one at a time and dips them into the tank of water. This blows the cores and cleans the sand off the castings leaving the metal clean and properly colored. Some care must be taken to dip the castings at the proper time or they will either be too cold and not blow enough to entirely clean out the core, or else they will be too hot and crack or take on too deep a tint.

The process of separating iron from the scrap is interesting. All yellow brass is made from scrap metal. This is received in cars which are run on a track above the scrap room. The metal is dumped off the cars and falls into bins in the scrap room. One of the bins is shown to the right in Fig. 6. From the opening of the bin at *B*, the scrap is shovelled upon a raised platform and falls over a magnetic chute, *C*, which holds any iron particles which are present with the scrap. The magnet at the chute was made by the Hays company along the lines of a magnetic chuck. Iron is separated from turnings by the machine in front of the barrels at the right. This separator was made by the Dings Electro-Magnetic Separator Co., Milwaukee.

The core room is another interesting department. A variety of cores are made and the sand mixture depends upon the kind of a core for which it is to be used. However the base of all cores is lake sand. This is sand dredged from the bottom of Lake Erie and can be obtained at a moderate cost. With this sand is mixed a small amount of new molding sand, or of foundry sweepings, or both, depending upon the class of cores to be made. This sand is mixed with an oil core compound in a sand mixer made by the Blystone Mfg. Co., Cambridge Springs, Pa.

A great number of different sized nails are used for strengthening the cores and some trouble was experienced in separating the different sizes of nails recovered from the castings. In separating them, nails frequently were put in the wrong lot, causing confusion when the coremaker wished to use them. In order to increase the speed of sorting the nails and to insure that all the nails get into the correct pile, H. H. Clemens, treasurer of the Hays Co., designed a special machine.

This machine is illustrated in Fig. 5. The protecting screen which covers the top of the machine when it is being operated, has been raised to give a view of the slots. The machine is driven by a belt attached to the pulley shown at the extreme left. The operator presses on a pedal with his foot to start it The machine is stopped as soon as the pedal is released, a feature which is advantageous in case of accident. The operator places a nail in front of each cross bar as it moves along the face of the machine. The cross bars come first to a slot through which the smallest size nail will fall, then to a slot which will allow the next size nail to pass, and so on until a slot is reached which is large enough to allow the largest size nail to pass. There are two rows of slots. The upper row is for wire nails and contains four divisions, the smallest passing a 6-pennyweight nail

and the largest a 20-pennyweight nail. Cut nails, from 6 pennyweight up to 30 pennyweight are separated into eight divisions in the lower row of slots.

A bank of core ovens is shown in Figs. 7 and 8. These ovens were designed by the late B. J. Walker of the Erie Malleable Iron Co., Erie, Pa., who is well known as a pioneer in introducing powdered coal burning equipment. The striking characteristic of the ovens is the method for distributing heat. Coke fires are burned on long, narrow grates running the same direction as the compartments. These grates are six feet below the floor of the oven, and this together with a natural, instead of a forced draft, gives a soft, even heat throughout the entire oven. The control of the heat is demonstrated by the procedure followed in baking. In the evening the ovens are filled with green cores and both dampers are closed; and in the morning the cores are baked and the fires still burning. One of the two sets of dampers mentioned is in the rear of the oven and the other is in the pipe on top of the oven, which carries the gases away. Dampers in the rear are partially shown at *A*, Fig. 8. These extend down more than six feet below the level of the grates. They are attached to wire cables which pass over pulleys and are counter weighted to facilitate raising the damper. At the tops of these dampers are small doors through which coke is introduced to the grate and the fire stirred. One of these doors is shown open at *B*, Fig. 8. The dampers in the rear control the air entering the ovens, while the dampers in the off-take pipe regulate the amount of air leaving the ovens. The cores are placed in stationary compartments on trays held in tongs as illustrated in Fig. 7. This figure also shows the doors, and the perforated compartment floor.

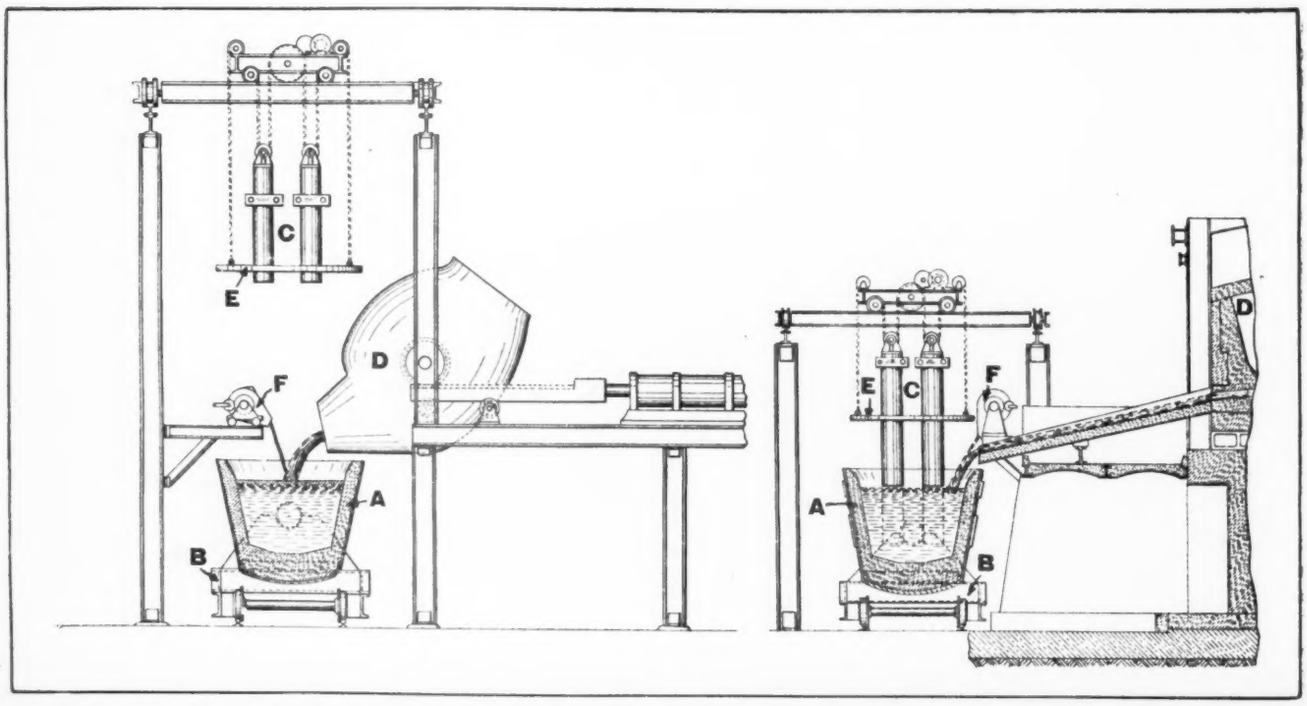
Electric Steel Refined in the Ladle

IN A patent recently granted to John McConnell, superintendent of the open-hearth department, Interstate Steel Co., Chicago, it is claimed that the quality of open-hearth or bessemer steel can be improved by subjecting it to the electric arc after it is in the ladle. It is said that by the use of Mr. McConnell's process a large tonnage can be treated at a minimum cost and that a more uniform product is obtained.

As shown in the accompanying illustrations, standard equipment is used. While the steel is being tapped into a ladle, the desired alloys in a cold state may be added to the streams of metal from a container, *F*, as shown in the drawing. It is preferable to introduce the alloys in the form of ferroalloys and crushed. Particularly in the case of chromium, it has been found that when the addition is introduced into the furnace, usually at the time or just before tapping, there is a large variation in the product. This is due to the alloy being subjected to furnace reactions which cause it to be oxidized and to go into the slag.

When the open-hearth furnace is tapped, all of the metal and slag, as is the usual custom, is directed into the service ladle. A small amount of slag is allowed to remain in the ladle for the purpose of keeping the steel hot, the remaining part being directed into a cinder thimble or slag pocket. The electrodes, *C*, are lowered into the bath, as shown below, and the current applied for approximately 15 minutes. This sets up a mixing action; removes the minute cavities of slag that have arisen from internal chemical actions, and also some oxygen, the oxides going into the slag and, effects further purification from sulphur.

In the basic process of steelmaking a substantial amount of the phosphorus can be removed. Sulphur, however, is more difficult and uncertain to control. If it is desired, when using Mr. McConnell's process, to remove sulphur from steel in the ladle by other means than temperature, which always is a potent factor in sulphur elimination, the slag is removed from the top of the metal and a new reducing slag made. This slag, on being heated by the arc, removes part of the sulphur and absorbs the oxides and other impurities.



THE ILLUSTRATION AT THE RIGHT SHOWS THE METAL BEING RECEIVED FROM AN OPEN-HEARTH FURNACE AND THE ELECTRODES IN PLACE FOR OPERATION BUT THE COVER *C* HAS NOT BEEN LOWERED—AT THE LEFT THE ELECTRODES ARE RAISED WHILE METAL IS BEING POURED INTO THE LADLE FROM THE CONVERTER

Factors in Choosing Molding Sands

Chemical Analysis is Not Sufficient in Itself to Supply Information—The Mechanical Texture and Composition of Sand Have a More Important Bearing on its Ultimate Fitness

BY P. G. H. BOSWELL

AFTER observing molding sand practice in numerous foundries both at home and abroad, the writer feels that the success achieved in nonferrous founding is more dependent on the individual skill of the molder or foreman than upon the application of scientific knowledge.

Steel is frequently cast at a temperature of 1600 degrees and sometimes above 1650 degrees Cent. when made in converters. The elimination of one of the most serious evils in steel casting, that of the sand burning on is at present an unsolved problem, essentially scientific in character. In good foundry practice the trouble may be reduced, but it has never yet been entirely eradicated.

On the other hand, both iron and nonferrous alloys are poured at temperatures which rarely exceed 1300 degrees Cent. Most sands when subjected to these temperatures for a limited period of time, remain essentially unchanged. The task of obtaining good sound castings is rather one depending on skillful molding technique than upon the chemical characteristics of the sand.

The casting temperatures of metals like lead or alloys like phosphor bronze are comparatively low, yet the skin of the castings may be rough or veined on account of the penetrating power of the molten material or burning on of sand. The production of semifused sand intimately mingled with the surface layers of the metal cannot always be definitely prevented. The problem is not an easy one to solve for burning on may result during the casting of lead at a temperature of less than 800 degrees Cent. and it is usually absent during the casting of manganese steel at a temperature reaching approximately 1600 degrees. Penetration of the sand by a mobile metal may be prevented by using sands of a finer grain and closer bond than those employed in steel or iron founding and by ramming them more tightly.

Iron and brass molding sands appear to be, in chemical and physical character, the same the world over, steel molding sands differ considerably from each other.

Tests of sands in the laboratory are necessarily preliminary only, and must be correlated with the results of actual practice in the works where the final tests should be made. When it is realized that many of the published records of chemical analyses are inaccurate and valueless it is perhaps not surprising that such analyses are held in little esteem by foundrymen. To take the case of one of the most important constituents of molding sands, the quantity of iron oxide recorded in the old analyses of well known molding sands is noteworthy as being five or six times too great.

British sands used for non-ferrous work can be divided into two classes. The Bunter sands contain material of the same geological age from different localities and therefore show similar composition and properties. The other class consists of sands from various geological horizons and shows little uniformity in constituents.

That sands from either class yield equally good results in casting, emphasizes the contention that in all foundry work the texture or mechanical composition of the sand is of great importance and that in nonferrous practice it becomes supreme.

Steel molding sands of the best quality possess a peculiar and characteristic mechanical composition, marked by the high proportion of coarse and medium grades, the relatively high proportion of clay grade and the low proportion or absence of the fine sand or silt grades. The mineral composition of sands may be determined by certain special methods, but it is of less importance in the case of molding sands than either chemical or mechanical analysis. From the point of view of practical application, the bearing upon each other of the chemical and mechanical composition of sands is of the utmost importance. This inter-relation is shown by making chemical analyses, not of the ordinary sand (bulk analysis) but of the various grades as separated by elutriation.

It is noteworthy that rolling out clays increases their plasticity, similarly the milling of molding sands increases their bond markedly. In metal founding the natural bond of molding sands is often supplemented by artificial bonds such as treacle, flour, dextrin, sulphite-lees, etc. Many of these artificial bonds are, like clay and ferric hydroxide, colloidal bodies which are characterized by their exhibition of surface phenomena—in this case particularly by their power of absorbing water. For foundry purposes the smallest quantity of water that will give the required bond should be used. The proportion is usually about 5 per cent or even less. Where the hot metal touches the mold the clay bond is killed, but not so the ferruginous bond. The sands with the longest life are rich in the latter.

The principal district for nonferrous foundry work in Great Britain is the Black country in general and Birmingham in particular. The city with nearly 400 nonferrous foundries is built on the red Bunter molding sand. The exhaustion of the supplies of Birmingham sand being within sight the resources of the adjoining area of the Bunter outcrop are being drawn upon.

It is interesting to find that although every country in the world contains sand suitable for the founding of nonferrous metals, such relatively cheap sands as those from Erith, Mansfield and Manchester have been exported, not only to European countries, but also to South Africa, India, Australia and even to the United States.

Abstract of paper presented at a meeting of the Institute of Metals Sept. 24-25 at the University, Sheffield. The author, P. G. H. Boswell, D.Sc.,F.G.S., is professor of geology in the University of Liverpool.

Engineering Firm Founded

The Production Engineering Co., 212 Center street, New York, has been organized to act as engineers to manufacturers. The firm will specialize in the designing and building of tools and machinery for automatic production. Catalogs are requested from machine tools and specialty manufacturers and the firm also wants to get in touch with all manufacturers of labor saving devices. John A. Honegger is president, Robert Steinman is treasurer and H. Allen Hinchcliff, secretary.

Westinghouse, Church, Kerr & Co., New York, have begun the construction of a new plant to comprise a new gray iron foundry and other buildings, for the George D. Roper Co., Rockford, Ill., which took over the plant of the Eclipse Gas Stove Co. Westinghouse, Church, Kerr & Co. also are constructing a new electric steel foundry for Pettibone, Mulliken Co., Chicago.

Speed Marks Auto Parts Molding

Co-ordination of Processes Similar to That Which Governs the Machining and Assembling of Cars Results in Remarkable Efficiency in Preparing Molds for Automobile Castings—Accuracy is Essential

BY D. M. AVEY

AUTOMOBILE manufacture owes much to the foundry industry. Foundry methods invented in antiquity and developed through the ages have been refined and adapted to the problems peculiar to the construction of automotive vehicles. Conversely the foundry industry recognizes and will in future have cause to appreciate yet more fully the lessons of progressive manufacture and quantity production which are being taught every day in the shops of motor-vehicle makers.

Castings, forgings and rolled metal products all enter largely into the automobile, but the most fundamental parts are, and have been, castings since the earliest conception of the horseless carriage. Cylinders, whether individual or enbloc are gray iron or semisteel castings except in a few cases. Transmission and differential housings are cast from iron or steel. Aluminum, steel or iron castings form the pistons and crankcases. Aluminum, brass or iron castings enter into carburetor and ignition parts and the numerous small pieces which are used for mountings and fittings about the chassis and body of an automobile. Heavier machines, such as freight handling trucks, tractors and farm power units in many cases use steel frames, wheels, drive sprockets and special supports.

Applied foundry knowledge has made possible the production of all these vital parts, and in turning them out foundrymen have been led to devise methods of molding, casting and alloying metals which might have remained unknown had not the impetus of the automobile industry furnished the necessary encouragement.

Automobile cylinders have formed the basis of study since the early days of manufacture. Multicylinder engines introduced problems in molding and in metallurgy which have become more and more complicated with each advance in automobile design.

The earlier types of cylinders depended upon copper jackets for circulating the cooling water which absorbs the heat developed in firing. It was thought that a complicated casting which would include the water-jacket with the cylinder block would develop stresses in cooling which later would result in failure. This theory gave way before practical experience and water-jacketed cylinders are now cast in huge quantities.

Earlier types of cylinder blocks which carried the water-jacket as an integral part, were exceptionally heavy and unnecessarily thick in section. Modern ideas, however, soon contributed a casting which became practically a standard for four cylinder engines. This type has been varied only in minor details to conform to the valve-in-the-head, T-head or L-head designs. With the fundamental questions of design satisfactorially disposed of, foundries during the past few years have been mainly concerned with production. The swift pace set in machining and assembling by the large automobile factories has been closely followed by the foundries. Shops handling this class of work are perhaps the most advanced in rapid and accurate molding methods and economical production.

The American Foundry Co., Indianapolis, specializes largely on automobile castings, and has develo ed

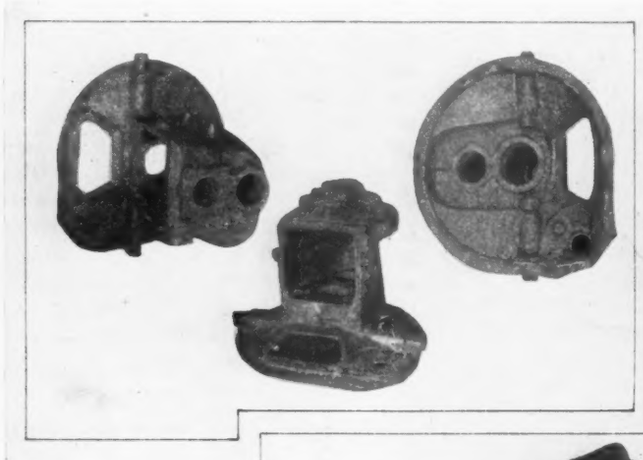


FIG. 1—THREE VIEWS OF TRANSMISSION HOUSING OF INTRICATE FORM

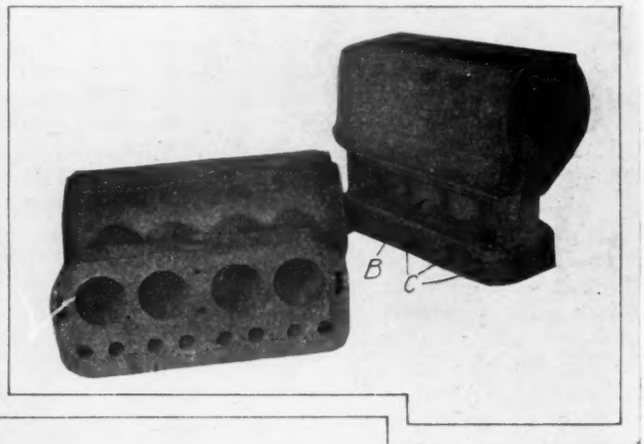


FIG. 2—CYLINDER AND CRANKCASE BLOCK FOR FOUR CYLINDER ENGINE

FIG. 3—CYLINDER HEAD FOR SIX-CYLINDER AUTOMOBILE ENGINE

DATA ON BELTS AND PULLEYS

By W. L. Tryon

(Concluded from Data Sheet No. 310)

Horsepower Per Square Inch of Belt Section Based on Barth's Formula

Velocity of belt Ft. per min.	Horsepower per sq. in. of belt section when angle of contact of belt on smaller pulley is												
	180°	175°	170°	165°	160°	155°	150°	145°	140°	135°	130°	125°	120°
2200	10.08	9.92	9.75	9.57	9.40	9.19	9.01	8.82	8.61	8.39	8.19	7.95	7.73
2250	10.26	10.10	9.93	9.74	9.57	9.36	9.17	8.98	8.77	8.54	8.34	8.10	7.87
2300	10.44	10.28	10.11	9.92	9.74	9.53	9.34	9.14	8.93	8.69	8.49	8.25	8.01
2350	10.63	10.46	10.29	10.10	9.91	9.70	9.51	9.30	9.09	8.85	8.64	8.40	8.15
2400	10.82	10.64	10.47	10.28	10.09	9.88	9.68	9.47	9.25	9.01	8.79	8.55	8.30
2450	11.01	10.83	10.65	10.46	10.27	10.06	9.85	9.64	9.41	9.17	8.94	8.70	8.45
2500	11.20	11.02	10.83	10.64	10.44	10.23	10.02	9.80	9.57	9.33	9.10	8.85	8.60
2550	11.34	11.16	10.96	10.75	10.57	10.36	10.14	9.92	9.69	9.45	9.21	8.96	8.71
2600	11.48	11.30	11.09	10.88	10.70	10.49	10.27	10.04	9.81	9.57	9.32	9.07	8.82
2650	11.62	11.44	11.23	11.01	10.83	10.62	10.40	10.16	9.93	9.69	9.43	9.18	8.93
2700	11.76	11.58	11.37	11.14	10.96	10.75	10.53	10.28	10.05	9.81	9.55	9.29	9.04
2750	11.90	11.72	11.51	11.27	11.09	10.88	10.66	10.41	10.17	9.93	9.67	9.40	9.15
2800	12.04	11.86	11.65	11.41	11.22	11.01	10.79	10.54	10.29	10.05	9.79	9.51	9.26
2850	12.18	12.00	11.79	11.55	11.35	11.14	10.92	10.67	10.42	10.17	9.91	9.63	9.37
2900	12.32	12.14	11.93	11.69	11.49	11.27	11.05	10.80	10.55	10.29	10.03	9.75	9.48
2950	12.47	12.28	12.07	11.84	11.63	11.40	11.18	10.93	10.68	10.41	10.15	9.87	9.59
3000	12.62	12.42	12.21	11.99	11.77	11.54	11.31	11.06	10.81	10.54	10.27	9.99	9.71
3050	12.70	12.51	12.30	12.08	11.85	11.63	11.40	11.14	10.89	10.62	10.35	10.06	9.78
3100	12.80	12.60	12.39	12.17	11.92	11.71	11.48	11.22	10.97	10.70	10.42	10.13	9.85
3150	12.88	12.69	12.47	12.25	12.00	11.80	11.56	11.30	11.05	10.78	10.50	10.20	9.92
3200	12.96	12.78	12.56	12.32	12.09	11.87	11.64	11.38	11.13	10.86	10.57	10.27	9.99
3300	13.14	12.96	12.73	12.49	12.24	12.04	11.80	11.54	11.28	11.01	10.72	10.42	10.13
3400	13.32	13.13	12.90	12.67	12.42	12.21	11.96	11.70	11.43	11.16	10.87	10.57	10.27
3500	13.51	13.30	13.08	12.85	12.61	12.37	12.12	11.86	11.59	11.31	11.02	10.72	10.41
3600	13.56	13.36	13.13	12.90	12.66	12.42	12.17	11.92	11.64	11.36	11.07	10.76	10.46
3700	13.62	13.42	13.19	12.95	12.71	12.47	12.22	11.97	11.69	11.41	10.12	10.81	10.51
3800	13.68	13.48	13.25	13.01	12.77	12.52	12.27	12.02	11.74	11.46	11.17	10.86	10.56
3900	13.74	13.54	13.31	13.07	12.83	12.58	12.33	12.07	11.79	11.51	11.22	10.91	10.61
4000	13.80	13.59	13.37	13.13	12.89	12.64	12.39	12.12	11.85	11.56	11.26	10.96	10.65
4100	13.72	13.51	13.29	13.05	12.81	12.56	12.31	12.05	11.78	11.49	11.19	10.90	10.59
4200	13.64	13.43	13.21	12.97	12.73	12.49	12.24	11.98	11.71	11.42	11.12	10.84	10.53
4300	13.56	13.35	13.13	12.89	12.66	12.42	12.17	11.91	11.64	11.35	11.06	10.78	10.47
4400	13.48	13.27	13.05	12.82	12.59	12.35	12.10	11.84	11.57	11.28	11.00	10.71	10.41
4500	13.40	13.13	12.97	12.75	12.52	12.28	12.03	11.77	11.50	11.22	10.94	10.64	10.35
4600	13.14	12.91	12.73	12.53	12.29	12.05	11.81	11.56	11.28	11.02	10.74	10.45	10.16
4700	12.90	12.68	12.50	12.30	12.06	11.82	11.59	11.35	11.08	10.82	10.54	10.26	9.97
4800	12.66	12.45	12.27	12.07	11.82	11.59	11.38	11.14	10.88	10.62	10.35	10.07	9.79
4900	12.42	12.23	12.04	11.84	11.61	11.36	11.17	10.93	10.68	10.42	10.16	9.88	9.61
5000	12.20	12.01	11.81	11.61	11.40	11.13	10.96	10.72	10.48	10.22	9.97	9.70	9.43

DATA ON BELTS AND PULLEYS

By W. L. Tryon

Area of Belt Section

Width of belt in inches	Area of belt when thickness in inches is												
	1/8	3/16	7/32	1/4	9/32	5/16	1/3	3/8	7/16	1/2	9/16	5/8	11/16
1	.125	.167	.188	.250	.281	.313	.333	.375	.438	.500	.563	.625	.688
1½	.188	.250	.281	.375	.422	.469	.500	.563	.656	.750	.844	.938	1.03
2	.250	.333	.375	.500	.563	.625	.667	.750	.875	1.00	1.13	1.25	1.38
2½	.313	.417	.468	.625	.703	.781	.833	.938	1.09	1.25	1.41	1.56	1.72
3	.375	.500	.563	.750	.844	.938	1.00	1.13	1.31	1.50	1.69	1.88	2.06
3½	.438	.583	.656	.875	.984	1.08	1.17	1.31	1.53	1.75	1.97	2.19	2.41
4	.500	.667	.750	1.00	1.13	1.25	1.33	1.50	1.75	2.00	2.25	2.50	2.75
4½	.563	.750	.844	1.13	1.27	1.41	1.50	1.69	1.97	2.25	2.53	2.81	3.09
5	.625	.833	.938	1.25	1.41	1.56	1.67	1.88	2.18	2.50	2.81	3.13	3.44
5½	.688	.917	1.03	1.37	1.55	1.72	1.83	2.06	2.41	2.75	3.09	3.44	3.78
6	.750	1.00	1.13	1.50	1.69	1.88	2.00	2.25	2.63	3.00	3.38	3.75	4.13
6½	.813	1.08	1.22	1.63	1.83	2.03	2.17	2.44	2.84	3.25	3.66	4.06	4.47
7	.875	1.17	1.31	1.75	1.97	2.18	2.33	2.63	3.06	3.50	3.94	4.38	4.81
7½	.938	1.25	1.41	1.88	2.11	2.34	2.50	2.81	3.28	3.75	4.22	4.69	5.16
8	1.00	1.33	1.50	2.00	2.25	2.50	2.67	3.00	3.50	4.00	4.50	5.00	5.50
8½	1.06	1.42	1.59	2.13	2.39	2.66	2.83	3.18	3.72	4.25	4.78	5.31	5.84
9	1.13	1.50	1.69	2.25	2.53	2.81	3.00	3.38	3.94	4.50	5.06	5.63	6.19
9½	1.19	1.58	1.78	2.37	2.67	2.97	3.17	3.56	4.16	4.75	5.34	5.94	6.53
10	1.25	1.67	1.88	2.50	2.81	3.13	3.33	3.75	4.38	5.00	5.62	6.25	6.88
11	1.38	1.83	2.06	2.75	3.09	3.44	3.67	4.13	4.81	5.50	6.19	6.88	7.56
12	1.50	2.00	2.25	3.00	3.38	3.75	4.00	4.50	5.25	6.00	6.75	7.50	8.25
13	1.63	2.17	2.44	3.25	3.66	4.06	4.33	4.88	5.68	6.50	7.31	8.13	8.94
14	1.75	2.33	2.63	3.50	3.94	4.38	4.67	5.25	6.13	7.00	7.88	8.75	9.63
15	1.88	2.50	2.81	3.75	4.22	4.69	5.00	5.63	6.56	7.50	8.44	9.38	10.31
16	2.00	2.67	3.00	4.00	4.50	5.00	5.33	6.00	7.00	8.00	9.00	10.00	11.00
17	2.13	2.83	3.19	4.25	4.78	5.31	5.67	6.38	7.44	8.50	9.56	10.63	11.69
18	2.25	3.00	3.38	4.50	5.06	5.63	6.00	6.75	7.88	9.00	10.13	11.25	12.38
19	2.37	3.17	3.56	4.75	5.34	5.94	6.33	7.13	8.31	9.50	10.69	11.88	13.06
20	2.50	3.33	3.75	5.00	5.62	6.25	6.67	7.50	8.75	10.00	11.25	12.50	13.75
22	2.75	3.67	4.13	5.50	6.19	6.88	7.33	8.25	9.63	11.00	12.38	13.75	15.13
24	3.00	4.00	4.50	6.00	6.75	7.50	8.00	9.00	10.50	12.00	13.50	15.00	16.50
26	3.25	4.33	4.88	6.50	7.31	8.13	8.67	9.75	11.38	13.00	14.63	16.25	17.88
28	3.50	4.67	5.25	7.00	7.88	8.75	9.33	10.50	12.25	14.00	15.75	17.50	19.25
30	3.75	5.00	5.63	7.50	8.44	9.38	10.00	11.25	13.13	15.00	16.88	18.75	20.63
32	4.00	5.33	6.00	8.00	9.00	10.00	10.67	12.00	14.00	16.00	18.00	20.00	22.00
34	4.25	5.67	6.38	8.50	9.56	10.63	11.33	12.75	14.88	17.00	19.13	21.25	23.38
36	4.50	6.00	6.75	9.00	10.13	11.25	12.00	13.50	15.75	18.00	20.25	22.50	24.75
40	5.00	6.67	7.50	10.00	11.25	12.50	13.33	15.00	17.50	20.00	22.50	25.00	27.50
44	5.50	7.33	8.25	11.00	12.38	13.75	14.67	16.50	19.25	22.00	24.75	27.50	30.25

For method of use, see preceding data sheets.

THE FOUNDRY DATA SHEET, DECEMBER 1, 1919
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

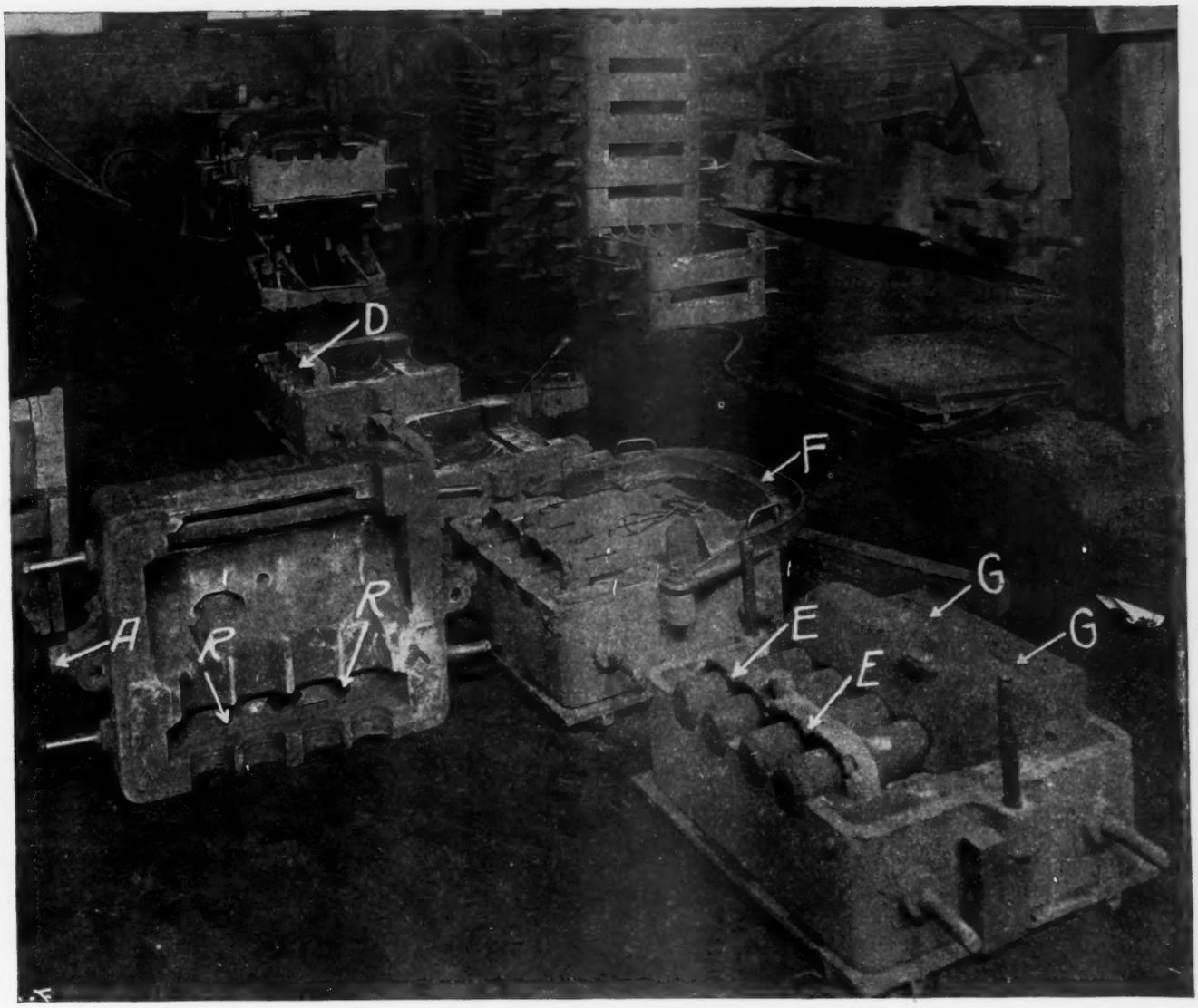


FIG. 4—LAYOUT FOR MOLDING THE CYLINDERS SHOWN IN FIG. 2—THE MACHINE USED FOR MOLDING THE DRAGS IS IN THE BACKGROUND

and applied extremely rapid methods to the molding of cylinder and crankcase blocks, transmission housings and cylinder heads.

A common type of cylinder and crankcase which is made in quantity by this company is shown in Fig. 2. This is an L-head design, provided with a water-jacket around the upper portion of the cylinders to match with a water-jacketed head which is a separate casting. In making this job, the American Foundry Co. makes use of a special flask and molds the cylinder block upon its side. The rig for this job is shown in Fig. 4. Two molding machines made by the International Molding Machine Co., Chicago, are used; one making the cope while the other produces the drag. With these two machines a gang of eight men makes and pours from 125 to 140 molds per day. A record of 22 molds an hour has been made.

One man from the molding machine gang cleans the pattern, sets the flask and drops in the facing sand while the other is slicking and cleaning the previous mold which has just been made. Both men then concentrate on throwing in the remainder of the

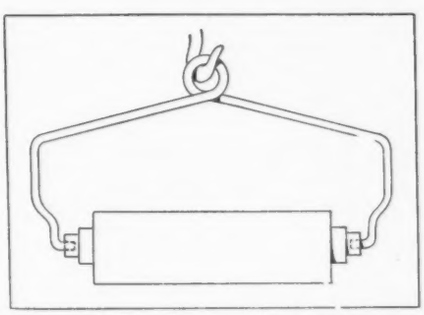


FIG. 5—DETAIL OF DEVICE USED TO LIFT THE DRAGS FROM THE MACHINE, TURN THEM AND SET THEM IN PLACE ON THE FLOOR

sand required. The mold is next jar-rammed on the machine and turned over, and the pattern is drawn by hand. The mold is finished and patched where needed and the carry-away gang of two men takes it from the machine to the floor.

The drags are clamped upon liberally vented steel bottom-boards before they are rolled over. The handles on opposite corners of the flask are engaged by a rope sling, and the drag and bottom-board together are raised from the machine and carried to the molding floor by an overhead air hoist. Special trunnions are provided on the cope flasks to enable them to be easily lifted and turned over; these may be noted at *A* in Fig. 4. These trunnions are engaged by a special rig shown at the upper right corner of Fig. 4, and in Fig. 5. The application of lifting force in the center of this rod at the point where the crane hook is engaged, causes the two ends inserted in the flask trunnions to pull toward each other, holding the flask firmly, but allowing free rotation upon the axis of the ends of the bar.

As may be noted, the flasks have a series of four semicircular recesses

FIG. 6—PORT CORE MACHINE SHOWING THE COMPLETED CORE ON THE TABLE OF THE MACHINE AT THE RIGHT

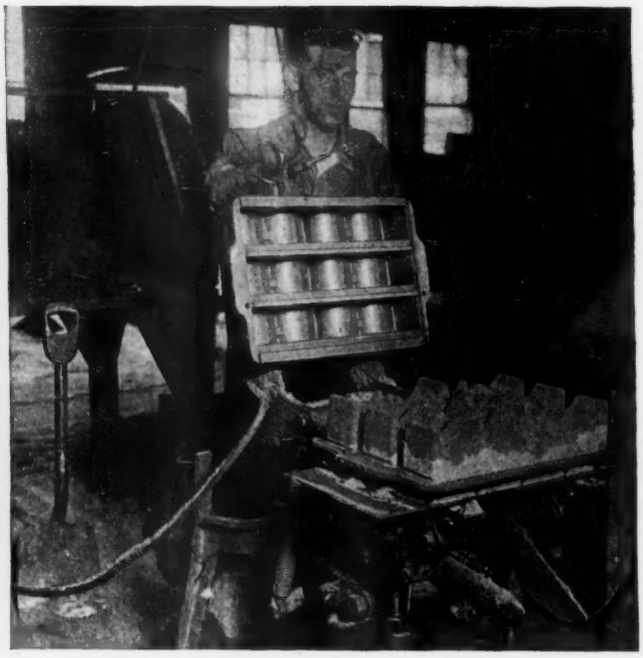


FIG. 6—METHOD OF MOLDING THREE SADDLE CORES AT ONCE

in the edge of one side and a rectangular slot in the opposite edge. These serve to support the two ends of the main cylinder and crankcase core which is made and set in place in two halves.

Although the cylinder molding method used in this shop is essentially green-sand work, a liberal number of cores are used. Two men set the cores and prepare the molds for closing. When the drag half of the mold is set on the floor the *saddle* core is placed. This is essentially a lightening core, but it forms the recess at *B*, Fig. 2. In this recess the springs which actuate the valves in the finished motor are made accessible for repairs and replacements. A core is used to form this part of the casting as the sharp angles would be subject to breakage in green sand, and any attempts at patching might lead to bubbling and defects when the mold is poured.

The bottom half of the water-jacket core, or *port* core as it is called, is set in position next. This is shown on the coremaking machine in Fig. 6. The port core is supported by five core prints at the points *C* illustrated in Fig. 2, while the eight valve ports are formed by the vertical bosses shown in the completed core resting upon the table of the machine in Fig. 6.

The upper half of the water-jacket core is placed upon this port core as shown at *D*, Fig. 4. This forms the hollow necessary to give thickness to the walls of the water jacket and small dowels make the openings in the upper surface by which the water passes from the jacket surrounding the cylinder to the hollow cylinder head. Small pieces of tin are placed in the recesses shown at *E* to form a bearing for chaplets which brace the core firmly against the cope when the mold is closed. This prevents the core from floating and takes some of the upward pressure which otherwise would be resisted by the center print

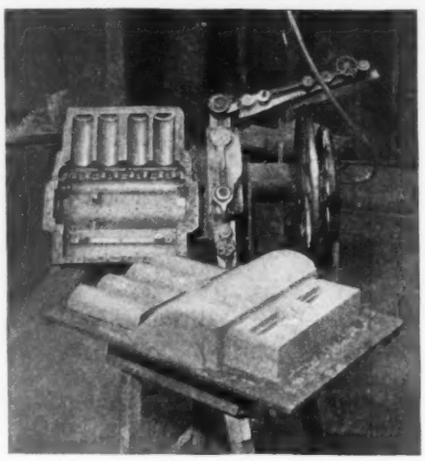


FIG. 8—THE MACHINE USED FOR MOLDING THE CORES FOR THE CYLINDER AND CRANKCASE CASTING

alone. This print, which may be noted at the center of the port core, forms the opening at the side of the water-jacket through which the cooling water enters.

With the saddle, port and jacket cores in place, the lower half of the combined cylinder crankcase core is set. This is supported upon a lateral print which extends through the side of the flask at the base of the crankcase and upon the four cylinder barrels which are carried through and rest upon recesses in the opposite side of the flask. The position of the lower half of this core is determined accurately by the position of the shoulders in the drag portion of the mold. A special jig is used to locate the upper half of the cylinder-crankcase core. This may be noted at *F* in Fig. 4. Two handles are set in the jig for convenience in lifting and setting it in place. Rigidly fixed pins which fit into the lugs at the ends of the flasks locate the jig accurately with reference to the imprint in the drag. The upper half of the cylinder-crankcase core then is lowered carefully by means of the two hand hooks which engage the core arbors through small openings. The half cylinders are inserted under the jacket core, and the entire core then is shoved forward until the base or crankcase portion of the core reaches the small shoulder on the jig and slips into its position against the bottom half of the core already in the mold. The cope half of the mold is swung into position, located by removable flask pins set in the lugs on the drag and dropped into place. The protruding ends of the cores are then luted with a mixture of molding sand and water, and the mold is ready for pouring.

The sand heap forms a basis about which the whole cylinder molding job is built. The two molding machines are mounted on wheel trucks and travel forward, one on each side of the sand pile. As the molds are completed they are swung into position in two or more rows just back of the

machines, so that at no time does the carry-away gang have to move over more than 10 or 12 feet. Cores are delivered upon small elevated carrying platforms built at a convenient height to enable the core assemblers to reach and lift the cores directly to the molds. Bottom boards and flasks are neatly piled at points only a few steps from the paths of the molding machines. In fact every minute detail which contributes to speedy action is studied with care. The small detail of the trunnions which were found so serviceable on the cope flask is typical. A rope sling serves at present for the drags, but the trunnion rig will save time, so the expense is deemed warranted and allowed without question.

The metal is poured into a single gate connected to two runners through the two strainer cores in the top of the upper cylinder-crankcase core, shown at *G*, Fig. 4. Two liberal connecting runners pass down through the bottom half of the core, allowing the metal to reach the bottom of the mold first, pass thence around the lower portion and up around the cylinders and water jackets. Two risers are set at the points marked *R*.

All the cores on the cylinder job are machine made. The half-section cores forming the cylinders and crankcase portion of the casting are hard-rammed on the machine shown in Fig. 8. Four long bar arbors are placed in the heavy portion of the core and four L-shaped bars, placed in the center of the cylinder barrels, are bent into the crankcase portion of the core. Three men make 150 of these cores per day.

The saddle cores are made, three at a time, on the air-squeeze, turn-over machine shown in Fig. 7. This was made by the International Molding Machine Co., Chicago. One man makes 200 saddle cores per day. These are liberally vented.

A hand roll-over machine, shown in Fig. 6, is used for the port core. One man operates this machine and with a night man makes all the cores of this type required. The average output is from 90 to 100 cores per day of nine hours. A loose piece is necessary in the box for this core. This is shown on the sand bench at the left of the illustration. The loose piece is drawn back immediately when the corebox is inverted, which permits the mold to be lifted free. A special plate which supports the five core prints at a slightly higher level than the rest of the core, is used to convey the core to the drying ovens. The jacket core is made in a manner similar to that used for the port core, but one man makes a sufficient number to supply all the molders on the floor.

The following sand mixture is used in making the cylinder cores: Fifty gallons of sand, 8 pints of a compound manufactured by the Werner G. Smith Co., Cleveland, and 3 pints of a binder made by the American Gum Products Co., New York. Eight core ovens provide capacity sufficient to handle all the cores needed in this foundry. All the cores are baked at night, five charges being made at intervals into coke-fired ovens. The cores are heated steadily for a half hour, they then are allowed to remain in the ovens for an additional 1½ hours and cool gradually before they are removed.

A cylinder head job which is handled by the American Foundry Co., again is typical of the methods pursued. This casting is shown in Fig. 3, and as may be noted, it is for a six-cylinder motor, differing only in minor details from the head which would be required for the cylinders just described. The head is molded with its upper surface down. This surface alone is molded in green sand. The water jacket space is formed by a core suspended from a second or cover core which serves a double purpose. The cover core forms the under surface of the casting and carries the waterjacket core suspended on wires fastened to the arbors of the two cores at several points. The green-sand drag is molded on an International roll-over machine operated by two men. The same men who operate the machine carry the molds and place them on the floor. A third workman sets the cover core with its suspended waterjacket core and places a rectangular weight across the mold resting upon the edges of the drag flask but lightly touching the cover core and sup-

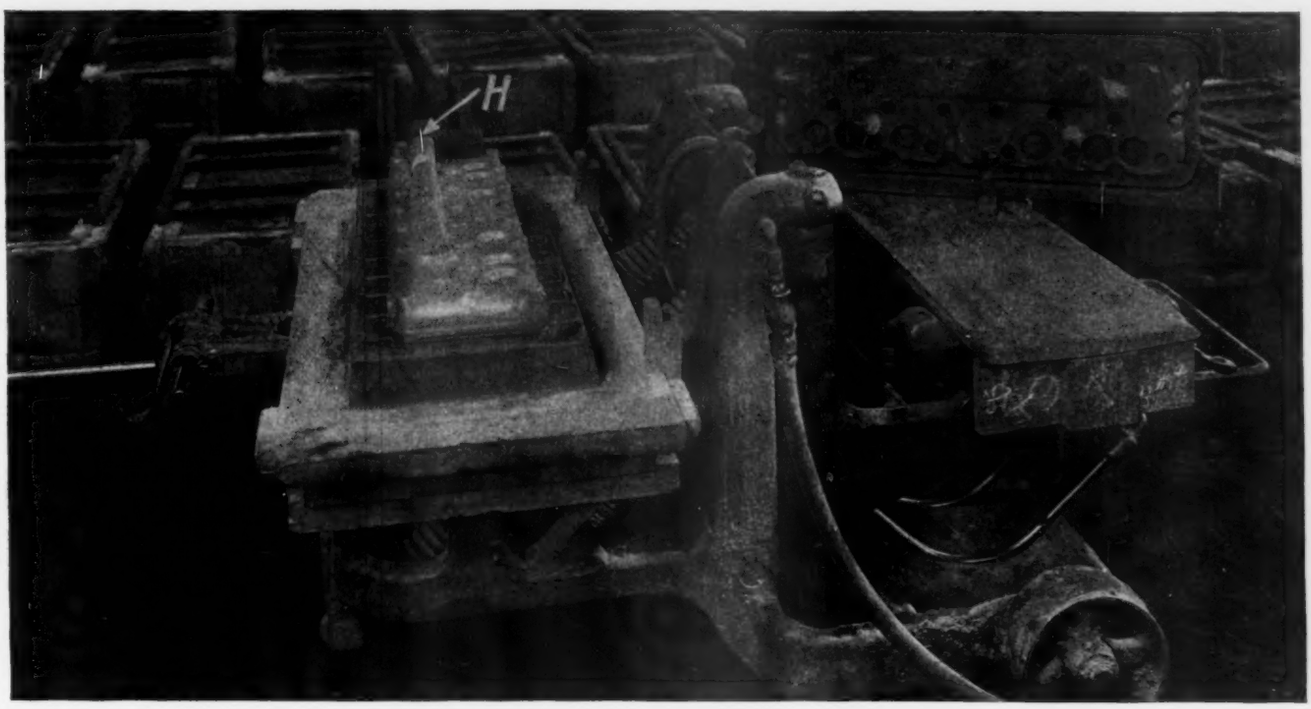


FIG. 9—MOLDING MACHINE, INNER AND COVER CORE FOR MOLDING THE CYLINDER HEAD SHOWN IN FIG. 3—NOTE THE CLOSED AND WEIGHTED MOLDS IN THE BACKGROUND

porting it against the upward thrust of the molten metal. The gang of three men makes on an average of 65 molds per day.

In molding the cylinder heads, a small core is placed to form the hollow and stop-off for the water outlet shown at *H*, in Fig. 2. A second core called a *step* core serves the double purpose of a ram-up core and a form for the boss shown at the forward end of the casting.

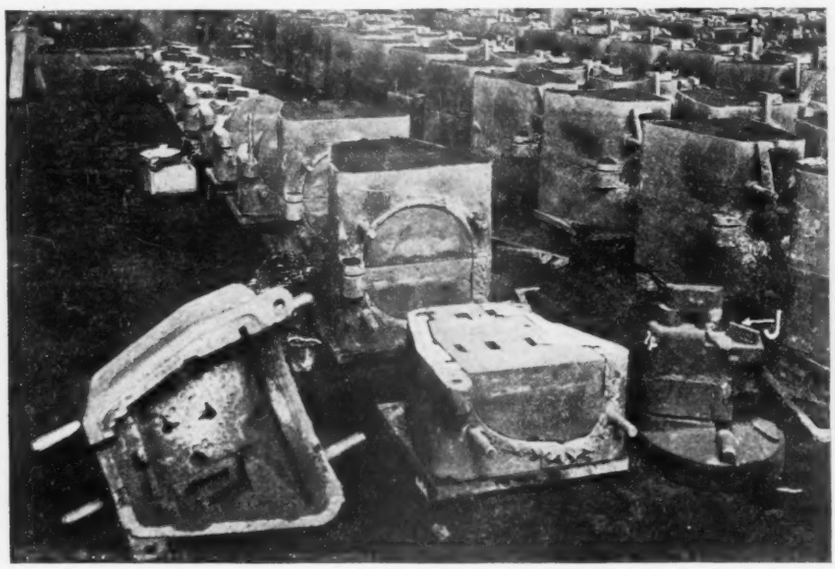
Similar in many ways to the general procedure employed in molding the cylinder crankcase casting, is that employed on a transmission housing job which this shop is making. However, a more elaborate rig is employed for the transmission molds, a floor of which is shown in Fig. 10. Special flasks trapezoidal in section are used. These require only a thin layer of sand to receive the impression of the pattern. This light thickness of sand is supported by cross bars which are cast integral with the flask. The bars or more properly webs adjoining the main flange section of the mold are cut in a semicircle to allow clearance for the cores. The light flask and small amount of sand used makes it possible to lift both copes and drags from the molding machines to the floor by hand. Lifting handles, two at each end, are provided for this purpose. The flasks are machined on the parting edges and pin lugs at two opposite corners are drilled together to guarantee accuracy in centering the flasks on the molding machines and in closing the molds.

The transmission housing castings are shown in Fig. 1. The parting line is plainly visible as indicated by a thin fin. All the complicated inner structure with the inner hubs and box sections are carried in a single split core. The outer surface with the main connecting flange which is bolted to the crankcase in the finished motor, is made in green sand in the two halves of the mold.

Two jolt-ram stripping-plate machines made by the Cleveland-Osborne Mfg. Co., Cleveland, are used, one to make the cope and the other the drag. Each of these machines is operated by two men. Two other workmen constitute a carry-away gang, placing the drags and closing the molds, while another man inserts the cores and yet another lutes the joints around and between the two half-cores. This gang of eight men makes and pours as many as 185 molds in nine hours. This speed again is attained through perfect coordination and foresight in planning.

The two molding machines are placed upon opposite sides of a sand heap, and the molds are removed and placed in double rows starting at a line about 40 feet from the machines and working back toward them. Facing sand is delivered in a box which has one side open and is fitted with supports which bring the bottom of the box to the height of the table on the molding machine. The flasks are piled in order only a short distance from each of the machines and the bottom boards are directly back of the drag machine. Two hand rammers are set ready at hand beside each machine and both operators peen the facing sand before the backing sand is placed and the table with the pattern and flask is jolted. All hand tools used are kept in designated places on the machine. As soon as a row of drags is set, two clamps and wedges are placed beside each, and the cores are delivered at the end of the aisle along which the molds are to be assembled. The bottom half core is set in place in each of the drags in succession, the top half core and small strainer core immediately following. The gang which is carrying the molds from the machine then brings a cope and drag alternately, placing the drag in a new row adjacent or setting a cope on the row of drags which is ready. Loose flask pins are used. These are removed and set ahead as each succeeding mold is closed. In Fig. 10 the last row of drags for the day has been completed and part of the coring is finished. The adjacent row is ready except for fixing and wedging the clamps which are leaned in position against the molds. When the molds are closed the end joints including the line between the two halves of the main core are daubed with a mixture of molding sand and water mixed to the consistency of mortar. This mixture has been found much more satisfactory for "mudding-up" than was a mixture of fire-clay which formerly was employed.

An interesting detail is observed in pouring these thin-sectioned, intricate transmission housings. A rectangular gate is formed in the cope directly over the portion of the casting which in the finished motor surrounds the transmission gears. This rectangular gate or box, about 3 x 4 inches, connects with a similar rectangular runner in the upper half of the core through a small circular tapered hole only about 1 inch in diameter at the top. A strainer core, shown at *J*, Fig. 10, is dropped into the rectangular gate in the upper portion of the core, before the cope is set in place. Thus the gate in the cope is in effect a pouring box



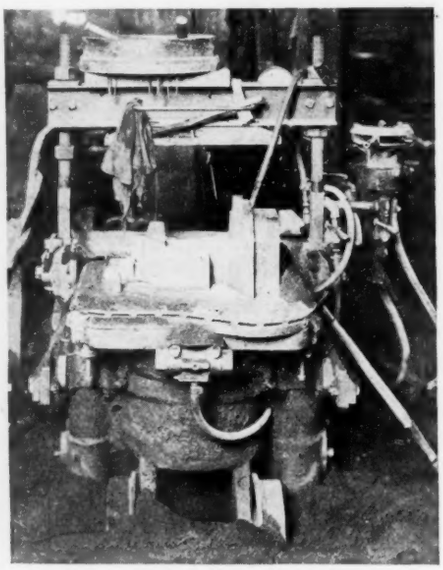


FIG. 10—FLOOR OF TRANSMISSION HOUSING MOLDS APPROACHING COMPLETION, WITH THE FORWARD MOLD DISASSEMBLED TO SHOW THE DETAILS OF CONSTRUCTION FIG. 11—STRIPPING-PLATE MACHINE USED FOR MOLDING THE COPES FOR TRANSMISSION HOUSING

in the green sand with a circular opening which leads to the strainer below. The circular opening is covered as soon as the mold is closed by a perfectly fitting disk of tin. When the metal is poured it rises in the gate floating to the top any impurities which are present, until the tin disk burns through allowing the metal to pass down through the circular opening and past the strainer through the runner to the bottom.

The two halves of the main core are made on two machines. Three men operate these two machines during the day and one machine is operated by one man at night. The total production averages 200 whole cores or 400 half cores each day. The drag core box has four loose pieces, two of which remain within the box when core is drawn, and two are drawn away laterally after the core is on the plate. The cope half corebox has two loose pieces which are drawn back when the core is out of the box. Two L-shaped rod arbors are used in each core. The same sand mix ture is used for the bell or main flange section of the transmission cores as is used for the cylinder cores, but the facing sand is dry sand mixed thick with the oil compound and the backing is mixed with the American Gum Products Co. binder previously mentioned.

Three Whiting cupolas, one lined to 54 inches and the other two to 60 inches, provide the metal for the various castings. The average melt is about 50 tons per day and the capacity is 70 tons. Automobile cylinders are poured from a metal of the following analysis:

	Per cent
Total carbon	3.30 to 3.50
Combined carbon	0.40 to 0.45
Graphitic carbon	2.80 to 3.00
Manganese	0.65 to 0.80
Phosphorus	0.30 to 0.35
Sulphur	less than 0.10
Silicon	2.00 to 2.20

This mixture develops a tensile strength of from 28,000 to 32,000 pounds per square inch. The transverse strength is from 3000 to 3500 pounds per square inch, and the Brinell hardness is from 410 to 430.

Another gray iron mixture which is used extensively has the following average analysis:

	Per cent
Total carbon	3.30 to 3.60
Combined carbon	0.35 to 0.50
Graphitic carbon	2.95 to 3.10
Manganese	0.60 to 0.80
Phosphorus	0.35 to 0.40
Sulphur	less than 0.10
Silicon	2.25 to 2.40

The tensile strength of this metal is from 25,000 to 28,000 pounds per square inch, the transverse strength from 2500 to 3000 pounds per square inch and the Brinell hardness is from 440 to 470.

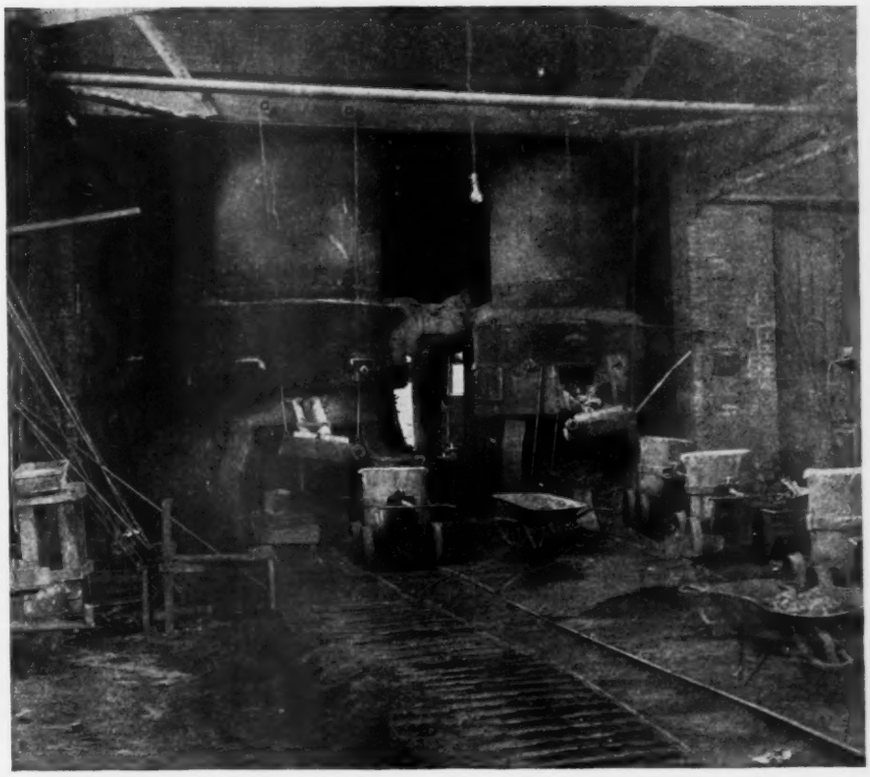


FIG. 13—TWO OF THE THREE CUPOLAS USED, SHOWING THE TRACK SYSTEM FOR LADLE CARS

About 300 pounds of coke per ton of iron is used in the cupola, and in some classes of castings a metal containing from 15 to 18 per cent of steel is used. The metal is poured from the cupola into ladle cars which run upon a system of tracks along the outer aisles of the two side bays and along a double track in the central aisle. Self-skimming hand shanks are used to carry the metal from the ladle cars to the different molding floors.

All castings are cleaned by tumbling. The cylinder castings are welded to correct minor defects which develop in a few cases. The welding room is shown in Fig. 12. Before welding the castings are placed in the oil-fired annealing furnace shown and raised to a cherry-red heat. They are removed and oxyacetylene welded while still hot. They then are returned to the furnace and annealed to remove any chance resulting stress.

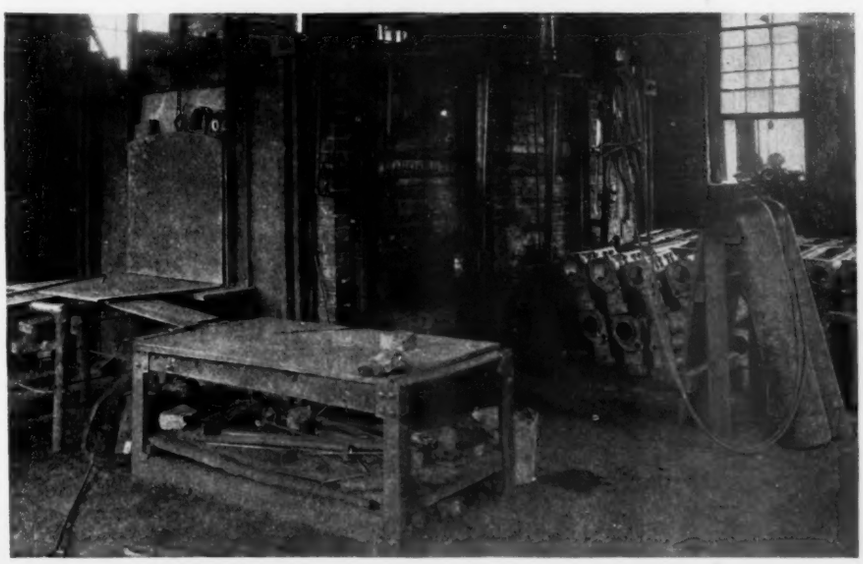


FIG. 12—ANNEALING OVENS USED TO PREHEAT CYLINDER CASTINGS FOR WELDING

The Kewaskum Aluminum Co., organized with $150,000 capital by local interests at Kewaskum, Wis., has purchased a 2½-acre site for a new plant. The first unit 60 x 200 feet will be erected during the winter. The following officers have been elected: President, A. L. Rosenheimer; vice president, Dr. N. E. Hausmann; secretary, B. H. Rosenheimer; treasurer, A. L. Rosenheimer Jr.

Castings From the Electric Furnace

Flexibility of This Melting Medium Recommends it to the Jobbing Foundry as Well as the Large Manufacturer—It Will Place Steel in the Ladle for From $35 to $40 a Ton

BY R. C. GOSROW

INITIALLY, the intention to engage in the manufacture of electric steel castings is influenced by several factors. The question is frequently studied from a purely remunerative standpoint. Then comes the consideration of the ease and dependability with which the electric furnace will make steel to meet the present rigid requirements of specifications for engineering materials which demand material of high grade and of a reliable and uniform character. The installation of an electric furnace for making steel appeals in one way to the manufacturer having an established plant, producing a finished machine or other product and not engaging in making castings for other firms. But it has a different aspect to the foundryman doing a jobbing business in a district producing large machinery, and requiring large castings of reliable material. Again the electric furnace appeals in a different way to the man in charge of a jobbing foundry in a district producing machinery requiring mainly small castings.

We may then analyze the utilization of the electric steel and iron furnace, for foundry use, somewhat as follows:

A steel foundry connected with a large manufacturing plant producing castings for its own use only: Making heavy machinery castings. Making light machinery castings such as automobile truck and agricultural machinery parts.

A steel foundry doing a jobbing business only: Making heavy castings principally; making light castings principally; making heavy and light castings simultaneously.

Let us consider a foundry operating in a certain territory and supplying large steel castings, up to 40,000 pounds in weight, for locomotives, ships, railroad equipment, industrial, and steel mill machinery, etc. The furnace which such a foundry would require would have a capacity of at least 50,000 pounds, which would mean a rated 25-ton unit. For making low-carbon steel castings under specifications calling for 60,000 to 70,000 pounds per square inch tensile strength, with 45 per cent of the ultimate in elastic limit; 18 per cent elongation in 2 inches, and 25 per cent reduction of area, a duplex process using the open-hearth and the electric furnace could be adapted. The cold scrap would be melted in the open-hearth furnace and the electric furnace would then act as a basic finishing unit, to desulphurize, deoxidize, degasify, and recarburize, and also to fix the steel's composition. If acid operations were carried on, the electric furnace unit would function as a deoxidizing, recarburizing and degasifying unit, and also for fixing the composition of the steel. With the regularity of such operations, electric furnace operating costs would be maintained at a minimum, and electric furnace maintenance costs would be exceptionally low, as referred to refractories and electrodes. This practice has been followed in several plants in this country.

In order to utilize the electric furnace in a duplexing process on steel, certain advantages must be guaranteed and demonstrated. Advantage is found in being able to melt the scrap steel in the open-hearth, by gas or oil, in large quantities, and maintain a reservoir of metal molten at all times to feed the electric furnace. As longer time is required to finish steel in the open-hearth furnace than in the electric furnace, more heats may be finished and more castings poured if the metal is transferred to the electric furnace for finishing as soon as being melted in the open-hearth furnace. Again, the metal from an open-hearth furnace of 100 tons capacity may be split up into four or five steel heats of different compositions if transferred to the electric furnace, should this be desired. Another advantage is that hotter heats may be made in the electric furnace, thus eliminating the occurence of cold shuts and misrun castings, and decreasing the weight of ladle skulls. The hotter the metal the more completely may it be degasified, which concerns the elimination of entrained air, with its oxygen and nitrogen contents. By charging hot metal to the electric furnace, current fluctuations are reduced to a negligible item, and the frequent power surges attending cold melting are absent, thus making a good power load. With the hot metal charge, the furnace builds up its electrical load rapidly, and the desulphurizing and deoxidizing slag may be made without delay after the metal is charged. The interval of time between heats, from tapping of one heat to the charging of the next, is not lost. Few agencies are so destructive to highly heated refractories, acid or basic, as the sudden chilling when a furnace is tapped and cold metal charged at once. Hot metal charging would considerably eliminate this difficulty and reduce the cooling interval between heats. Another advantage of the duplexing process, under the present consideration, is the decreased amount of molding floor space required owing to the fact that pouring would take place more frequently.

A plant with such equipment could readily switch its electric furnace over to producing gray-iron castings. In this case the iron scrap would be charged cold into the electric furnace for melting; or a duplexing process with a cupola could be used. The addition of a cupola to such a plant, would give the most flexible operating conditions desired. The products of such a plant could constitute castings of duplex electric steel, duplex electric gray-iron, prime electric steel, or prime electric gray-iron. This outline then would cover the

Electricity Appraised

WONDERS accomplished by electricity have been so startling that a glamor is cast about the word and any operation associated with it is likely to be overestimated in its results. This was true of the electric furnace process for making steel. When first introduced, extravagant claims were made for the product and, to some extent, in regard to the metallurgical reactions which take place in the furnace. Mr. Gosrow has tabulated data from a number of tensile tests which show what may be expected from a low-carbon steel made in the electric furnace. He also outlines the metallurgical reactions which take place and explains the reasons for the different effects, showing that an oxidizing atmosphere is necessary to remove phosphorus and a reducing atmosphere is required to free the steel from sulphur. Under both of these conditions a lime slag is essential and these reactions are therefore confined to the operation of the basic lined electric furnace.

operations of a plant making large castings only and installing the largest, most economically sized electric furnace.

A foundry producing only light castings would encounter a different set of conditions from the case above cited. The production of small castings from a few ounces up to 1500 pounds in weight means large molding floor space. A unit of the most efficient capacity to consistently keep pace with the production demands of the shop must be installed. The furnace should be kept operating and the molders should not be interfered with for lack of floor space. For the most flexible operation, a furnace should be installed which will have about 25 per cent additional capacity, over the anticipated maximum production demand. This would give a unit which would be economical during minimum production, yet large enough to produce a maximum, both in daily tonnage and unit heat poured.

Small Furnace Recommended

As the productoin of small castings requires hot heats, and not too large heats, the desirable medium would be a furnace of one to three tons capacity. Such a furnace operating with an acid bottom should melt and finish a heat in 2 hours on the average; while for basic operation 2½ to 3½ hours would be an average. These figures are based on both operations producing 0.25 per cent carbon steel castings, with sulphur and phosphorus in acid practice each 0.07 per cent maximum, and in basic 0.04 per cent maximum.

The most economical grade of scrap to use would be 80 per cent of the charge in clean, coarse, heavy turnings, with 20 per cent of the charge foundry sprues; or about 10 per cent sprues and 10 per cent drop forge crop ends and tong holds. These materials melt up rapidly and may be charged easier than most other grades of scrap materials. Heavy materials should be avoided, as they are charged slower, and require more time to melt. In small furnaces heavy chunks of scrap destroy the door sills, banks and hearth. By operating 1½ to 3-ton furnaces, pouring the metal from the furnace to a bull ladle, then shanking off in 150-pound pots, the furnace is never held idle for long periods to pour off, as is usual when shanking is done direct from the furnace.

While it is true that the rapid heating and cooling of the lining in small, fast operated furnaces is deteriorating on the refractories, it cannot be prevented when cold charging is practiced. Yet considering the weight of the lining material and the heat stored up in it, compared to the weight of the cold metal charged, it can be seen that the deteriorating effect of heating and cooling would not be as great in a 3-ton furnace as it would be in a 10 or 25-ton unit. Besides it would not be practical to run a mixer in connection with a 3-ton, or smaller unit. Cold charging is therefore the preferable method for smaller furnaces.

By installing a furnace with an automatic electrode control, with mechanism to tilt back for slag skimming and forward for pouring the metal, a labor-operating crew consisting of one man can tend the furnace, except at charging time, when two additional men would be required for short intervals. A 1½-ton furnace operating by acid process, should melt and finish a heat with an energy consumption of not over 650 kilowatt hours per ton poured, while a 3-ton furnace should get out a heat with not over 600 kilowatt-hours per ton poured. On basic operation these figures would average 50 to 100 kilowatt-hours greater per ton poured. These figures pertain, of course, to plain carbon steel castings.

Frequently a large manufacturing concern engages in the production of the steel castings which enter into the manufacture of its final product while many users of steel castings, although they have foundries to produce gray-iron and brass castings for their own needs, purchase steel castings from other firms. This brings up the question of the advisability for a firm to make its own steel castings.

Production of steel castings in a large manufacturing institution, means another department for the management to handle. It means a new organization in a plant which may already be over organized and too integrated. Then should there come a business depression the steel foundry would have to suffer; it would be necessary to lay off men, the machinery and equipment would stand idle, and the organization be broken up. These factors in turn affect other departments of the same plant. The purchase of materials for the steel foundry puts additional strain on the purchasing department and adds to the large variety of material with which the department must be familiar. The installation of a steel foundry would also require an investment in buildings, equipment, supplies, etc., and the interest and

Table I

Cost of One Net Ton of Electric Furnace Steel in the Ladle*

Item	Pounds	Unit cost	Cost per 2000 lbs. metal 1½ ton	3 ton
Turnings .....5% loss	1680	$15.00 net ton	$12.60	$12.60
Sprue .....2% loss	410	13.50 net ton	2.70	2.70
Limerock	200	5.50 net ton	0.54	0.54
Fluorspar	15	30.00 net ton	0.23	0.23
Carburizer	4	12.00 net ton	0.02	0.02
Ferromanganese 80%	18	8½c pound	1.53	1.53
Ferrosilicon 50%	20	7½c pound	1.50	1.50
Power—700 K. W. Hrs. @ 1.25 cents.....			8.75	....
Power—650 K. W. Hrs. @ 1.0 cents.....			....	6.50
Electrode—nongraphitized—20 pounds 8½c pound.....			1.70	1.70
Linings—New				
Roof			0.45	0.45
Walls			0.50	0.40
Hearth			0.20	0.15
Linings—Repairs				
Banking materials			0.50	0.40
Roof patching			0.15	0.15
Spout and slag doors.....			0.20	0.25
Ladles—				
Linings			0.60	0.50
Drying—Oil			0.50	0.50
Furnace tools—steel bars, skimmers, etc.....			0.50	0.50
Labor—				
Superintendence—20 per cent of time to furnace at $500 per month.....			0.30	0.20
Head melter—2 work 10 hours @ $6.00 each.....			0.89	0.57
Ladle liner—2 work 12 hours @ 45c hour.....			0.83	0.52
Labor charging furnace—2 @ 40c hour.....			0.53	0.27
Scrap yard labor—2 men 10 hours @ 40c hour.....			0.59	0.38
Chemist $200 per month.....			0.58	0.38
Laboratory supplies—$50 per month.....			0.15	0.10
Unproductive payroll			1.00	0.75
Depreciation of furnace installation.....1% per year			0.57	0.57
Amortization fund on furnace installation.....1% per year			0.57	0.57
Interest on furnace installation only.....7% per year			0.33	0.33
Insurance, etc.			0.04	0.04
Total cost per net ton of metal in the ladle.....			$39.55	$35.31

*Steel composition desired:

Carbon	0.22—0.28 per cent.
Manganese	0.55—0.70 per cent.
Silicon	0.40—0.55 per cent.
Sulphur	0.045 per cent maximum.
Phosphorous	0.040 per cent maximum.

Furnace capacity per unit heat and production:
Producing from 1½ ton unit, 9 heats, 13½ tons.
Producing from 3 ton unit, 7 heats, 21 tons.

Power capacity of furnaces:
1½ ton; 600 KVA.
3 ton; 1000 KVA.

Scrap melted:
Steel turnings, 80% of charge. 0.20—0.30 carbon.
Foundry sprue 20% of charge, 0.20—0.30 carbon.

depreciation charges would have to be met by the profits of the steel foundry.

It would appear, however, in spite of the foregoing arguments against it, that a steel foundry would be a paying investment for many concerns. The quantity of scrap material accumulating is considerable in any large manufacturing plant and a big portion of this scrap is steel. The scrap steel of course, is sold at good or poor prices, depending on the market, and directly bears on the prices paid for new materials. However, the manufacturer might convert it into a product for which he pays good prices when buying his castings, if he established his own steel foundry.

In the large manufacturing plant considerable accessory equipment could be utilized in operating a steel foundry. Such equipment already in the plant and which is needed for a steel foundry would consist of water pumping machinery, air compressors, transformers for power and lighting circuits, spur trackage, industrial trackage, yard cranes for unloading raw materials and handling the castings, fire protection systems and shops in which its own equipment may be made and repaired. Engineers of wide experience, an efficient employment department, trained office help with a systematized method of keeping accounts, and usually good financial support are among the other advantages which a large organization offers for adding another unit to its plant.

A large machinery manufacturer would undoubtedly require castings of a wide range of weight and would have to equip his foundry to make the largest as well as the smallest castings which would be needed. For economy he should keep his furnace running continually and produce all his work, both heavy and light. This condition would be a hardship on the foundry. At times it would have a surplus of heavy work to turn out quickly, and at other times a majority of light work. In order to take care of the fluctuations it would be necessary to over-man his foundry. This condition would be undesirable as well as unprofitable. However, the difficulty, in many cases, might be somewhat obviated by running the foundry to produce castings for stock.

Advantage in Regular Production

Manufacturers of parts for automobiles, trucks, tractors, agricultural machinery, rock and ore crushing machinery, and other similar lines could advantageously introduce the electric furnace. The universal use of such machinery, guarantees to the manufacturer a continual market for his product. With the quantities of castings required daily a steady, never failing production must be maintained. This means that the electric furnace could be maintained at maximum production. Such a manufacturing plant would enjoy a considerable advantage in producing its own castings. In the first place a desirable supply of turnings, etc., would accumulate for an electric furnace charge from the quantity of material machined. Then, too, the foundry practice could be improved and standardized through studying results and investigating their causes. At the same time improvement could be made in the grade, composition, and quality of the steel.

The manufacturer of machinery, as previously stated, uses many gray-iron as well as steel castings in his machines. The flexibility of operation of a well designed and equipped electric furnace should appeal strongly to such manufacturers. By operating the electric furnace for producing gray-iron and steel castings, by basic or acid processes, a unit would be at hand which would produce castings of the highest physical properties, and at the same time replace a cupola for iron, and a converter or crucibles for steel.

An electric furnace for such requirements would be most suitable in a 1½ to 3-ton unit. In a furnace of such capacity, repairs to the refractories could be quickly made. Quick heats could be produced of such a size that the chemical composition could be closely controlled and changed readily when desired.

A Study of Costs

Back of all the arguments pro and con is the cost question. If the cost were excessive it would bar the electric furnace. But it has been proved that electric furnace steel costs are not excessive. In Table I figures are given showing the cost of producing one net ton of 0.25 per cent carbon basic steel in the ladle.

From this estimate, which it is safe to state is not over 10 per cent plus or minus from actual foundry costs in manufacturing centers of this country, it may be seen that there is not a wide difference of costs between the two sizes of furnace providing both are run to normal capacity. The ultimate cost of electric furnace steel in the ladle is lower than the cost of other methods of producing the same analysis steel in the same unit quantities. The reasons are:

Less oxidation losses of metal in melting down the charge.

A less gasified steel, not requiring as much time to finish the heat.

A steel containing less oxygen and oxides, thus not requiring the quantities of silicon for deoxidizing.

A less oxidized steel, consequently more economy in the use of manganese and other alloys, otherwise lost by oxidation.

A more fluid steel, thus giving homogeneity and better absorption of the alloys added.

Production of a hot metal and thus eliminating cold shuts and misrun castings.

The ease of manipulation and control of the electric furnace, decreases labor needed to operate it.

Producing quick, small heats: The foundry can be operated more economically when casting is going on at regular intervals all day.

The ability to carefully control the analysis desired eliminates loss by off heats and scrap castings.

Money is saved on interest and investment by using a small unit, producing several heats per day, than by using a large unit or greater unit production, but less heats per day.

Electric Companies a Factor

While the electric furnace has developed in favor among foundry and mill men, its advance would have been seriously impeded and delayed if it had not been fostered and backed by the power generating companies. Through the loyal and scientific cooperation of generating and distributing electrical engineers, metallurgists and foundrymen, the electric furnace has developed to be an apparatus favored and promoted by all three of these interested groups.

Initially when electric furnace loads were put on some of the power company's lines, it became apparent that certain refinements were necessary to safeguard other customers taking power from the same lines. Then, also, it was found that an electric furnace load on a small feeder system caused too great fluctuations of power. Where favorable conditions warranted it, power company lines were consolidated to feed through a larger system and thus take care of an urgent demand from customers who were installing electric furnaces. But now with the three-phase furnaces in operation, having regulating and safety devices, the power companies are anxious to get such customers. As most of the heavy peak loads of the generating companies come during the morning and evening hours, the hours of the night and day present periods of surplus power available. If a manufacturer can regulate his output so as to refrain from operating the furnace during peak load periods, he can secure concessions in his power rate. The ease with which an electric furnace may be started and heated up makes this practice of operating the furnace on off-peak periods practical, and the furnace need be shut down

only about 6 hours out of 24 hours. This schedule, of course, pertains to the foundryman who has a large tonnage to produce, and who operates his plant on a 24-hour day schedule, which practice is followed in some plants throughout the country.

At the present time, various large electric generating and distributing systems require that electric furnaces on their lines shall be three-phase furnaces. This is to eliminate the unbalancing and overload on their feeder lines and generators, caused by single phase units, with their resultant low power factor. When electric furnaces first came into use single-phase furnaces were tolerated by the power companies. But with the increasing application of the electric furnace, and the large loads which are required, the single-phase units became undesirable, and today some power companies require, before issuing a power contract, that a three-phase furnace be installed.

The objection is often made among buyers of electric energy for electric furnace use, that their unit energy charges are not consistent, or that one has a lower unit rate than another. The amount of money paid for electric energy is derived from and figured on how much energy is used per month, and when it is used during the 24-hour day. An example of the method of calculating rates of charge are illustrated in Table II. Calculations are given of two furnaces with different demand charges and varying energy consumption. The demand charge is a charge for capacity and is based on the largest amount of power the furnace will take. This is merely a charge by the electric company for standing ready to deliver power of a stated number of kilowatts. The consumption charge, on the other hand, is for power actually used. The figures in Table II show clearly the effect of a low energy charge with a high demand. The furnace in plant *A* was not running near to capacity. It was also running slow, as evidenced by the time to make three heats. The furnace in plant *B* was running nearer to capacity and had a higher demand but also a much greater energy consumption which made the charge per kilowatt hour less for plant *B* than for *A*.

Table II

Methods for Determining Rates Under Differing Conditions

PLANT A		PLANT B	
Furnace—3 ton; 3 phase.		Furnace—3 ton; 3 phase.	
Transformer, 1000 KVA.		Transformer, 1000 KVA.	
Process, basic.		Process, basic.	
Operating 3 heats in 12 hours.		Operating 6 heats in 18 hours.	
Maximum demand, 1500 KW.		Max mum demand, 1750 KW.	
Energy consumption per month, 168,750 KW hours.		Energy consumption per month, 315,000 KW. hours.	
Tonnage per month, 225 tons—net.		Tonnage per month, 450 tons—net.	
DEMAND CHARGE			
Kilowatts		Kilowatts	
200 @ $1.50	$ 300.00	200 @ $1.50	$ 300.00
800 @ 1.25	1000.00	800 @ 1.25	1000.00
500 @ 1.00	500.00	750 @ 1.00	750.00
1500 KW.	$1800.00	1750 KW.	$2050.00
ENERGY CHARGE			
100,000 Kilowatt hours @ 1.0c	$1000.00	100,000 Kilowatt hours @ 1.0c	$1000.00
68,750 Kilowatt hours @ 0.9c	618.75	215,000 Kilowatt hours @ 0.9c	1935.00
168,750 Total	$1618.75	315,000 Total	$2935.00
Demand charge	$1800.00	Demand charge	$2050.00
Energy charge	1618.75	Energy charge	2935.00
Total	$3418.75	Total	$4985.00
AVERAGE CHARGE PER KILOWATT HOUR			
Plant A average	2.02 cents	Plant B average	1.58 cents

When using the electric steel furnace for manufacturing castings, it must not be assumed, that any aggregate of poor materials will produce the highest grades of steel. It must also be remembered that an electric steel furnace is not a cure for all troubles with steel and castings. The electric steel furnace is a high class piece of steelmaking apparatus and must be intelligently used and operated. Only in this way can the economies and high grade product claimed for it be realized. The proper grade and physical condition of raw materials also must be considered.

For producing acid carbon steel castings, an electric furnace may be most efficiently operated with a rapid output of heats. But the raw material available would determine whether it would be advisable to use this process instead of the basic process. Scrap for acid steel castings should not contain more than 0.045 per cent sulphur and phosphorus as there is always an increase of sulphur and phosphorus when steel is melted in an acid-lined furnace. A 0.06 per cent sulphur and phosphorus content should be the high limit for steel made by the acid process. As the increase in percentage of sulphur and phosphorus in the final metal is due to the oxidation of iron in melting down, the electric furnace acid operation does not cause as high an increase in the percentage of these elements as does the open-hearth with its greater oxidation losses. The scrap selected should also be physically clean and free from sand, scale, rust, and refuse, such as shop sweepings.

On the other hand, scrap used in a basic furnace may have any range of sulphur and phosphorus contents, providing the cost of freeing the metal from them is within commercial limits. A metal from the basic furnace, containing 0.04 per cent sulphur and phosphorus is acceptable and may be obtained from scrap which runs from 0.06 to 0.07 per cent in these elements. When considering the question from the financial side we see that the cost due to refractories, power, and slag making materials is higher in the basic than in the acid process, but cheaper scrap may be used in the basic furnace. The price of scrap and the cost of power in any locality are factors which frequently determine whether a furnace should be provided with an acid or a basic bottom.

The purpose in melting steel in a furnace with basic hearth and banks is to oxidize the phosphorus, and then combine the phosphorus pentoxide produced with lime. These form a calcium phosphate which is held in the slag. The conditions for good dephosphorizing must be oxidizing, with an excess of lime present in the slag. In the acid operation of melting, oxidation takes place, but a phosphate of iron is formed instead of calcium phosphate because there is no lime present to unite with the phosphorus pentoxide. The first slag that forms in the acid furnace is a black, glassy silicate of iron with some iron phosphate. This phosphate of iron is easily reduced and the phosphorus goes back into the metal and none is carried away by the slag.

During the final period in which the steel is refined the atmosphere over the metal is decidedly neutral and reducing in character. The term refining generally implies basic operation, but it may technically mean the finishing and completion of the steel, either in basic or acid operations. In the acid process refining might be considered to consist of the elimination of gases, solid oxides and slag from the metal. The operation also includes securing the desired composition of the metal by the addition of alloys, etc. In the basic process, refining constitutes the elimination of sulphur, gases, solid oxides and

slag, and final fixing of the chemical composition. The elimination of sulphur is the one element of operation which strongly distinguishes it from acid operations. As desulphurizing of steel in the basic process is a series of chemical reactions, the proper conditions must be maintained to achieve the result. Primarily, desulphurization is a reducing process. When the metal is melted and after the first ferrous-lime slag is removed, the steel is contaminated with oxides, both solid and gaseous. Although the metal is melted it is not in its most fluid quiescent state. At this stage lime is added, along with carbon, for the purpose of forming a carbide of lime on the surface of the metal. This combines with any silica present and forms a slag. As carbide of lime, or calcium carbide, is a strong reducing agent, the sulphur of the iron sulphide in the slag combines with the calcium and forms calcium sulphide, which goes into the slag as a very liquid compound. The oxygen in the solid and gaseous oxides present, combines with the carbon and forms carbon monoxide and carbon dioxide, which go off as gas. The iron oxide in the metal has now been reduced to iron, the oxygen has passed off as an oxide of carbon, and some of the sulphur is in the slag, combined with calcium. In the acid process this procedure does not follow, because it is impractical to add a strong base, such as lime, to a strong acid refractory, like silica. So in the acid process desulphurizing is not carried out, and better grades of scrap are necessary to make a final metal sufficiently low in this element.

As the uniform physical properties of a metal depend on its homogeneity, it would appear primarily essential that electric steel be homogeneous. When properly made from suitable materials, steel from the electric furnace is homogeneous. Heterogeneity is due to unsatisfactory and poorly selected raw materials, haste and lack of skill in operations, and a misunderstanding or ignorance of what the electric furnace requires in producing the high grade product it is capable of making. As an indication of the quality of such steel the results of some tensile tests of basic electric steel, after it had been annealed, are given in Table III which is shown on this page.

During the war electric steel was specified for castings, where toughness and high ultimate strengths were desired, and also where assurance of uniformity was necessary on account of the expensive nature of taking test specimens. Electric steel was produced continually and with small losses under United States navy specifications on No. 1, No. 2, and No. 3 for steel castings. Due to the condition of the scrap market, it was often not economical to make steel castings to No. 3 navy specification in any other but the electric furnace.

A subject which has had very little attention to date, and one in which possibilities exist, is the heat treatment of castings. The only heat treatment generally given a steel casting is to anneal it. This normalizes the steel, and reduces casting strains. But the transposition and transformation of its crystalline elements, as yet has not been practically applied. A casting, due to its shape, often cannot be subjected to the action of quenching media, such as bars and forgings are put through. Often the difference of thickness of parts of the same casting would prevent a good heat treatment to all parts. The subject presents many difficulties, but also many advantages when worked out. Electric furnace steel should be amenable to such treatment, on account of its homogeneity, which is a credential for successful heat treatment.

Table III

Tensile Tests of Basic Electric Steel

Test number	A	B	C	D	E	F
Carbon	0.49	.44	.41	.39	.53	.31
Manganese	0.51	.56	.66	.65	.66	.61
Silicon	0.26	.37	.33	.37	.33	.59
Sulphur	0.041	.043	.047	.045	.047	.035
Phosphorus	0.036	.035	.042	.044	.043	.035
Utimate strength, lbs. sq. in.	93,000	84,000	83,400	85,300	103,500	84,400
Elastic limit, lbs. sq. in.	44,500	42,800	44,000	45,300	48,300	44,500
Per cent elongation in 2"	17.0	17.2	18.5	19.0	16.5	18.2
Reduction of area; per cent	20.2	20.1	23.8	24.1	20.0	21.8

Brass Production Grows

The output of semifabricated brass products for the country in 1917, the only recent year for which a government or any other authoritative report has been made, was 1,072,508,000 pounds. The word "brass" is here used to include similar alloys. These figures were published recently in the nonferrous section of *History of Prices During the War*. The pamphlet was written under the direction of the war industries board, with Wesley C. Mitchell as editor, and H. R. Aldrich and Jacob Schmuckler as assistants.

Included in the foregoing total brass output, was the 120,266,000 pounds of brass castings. This item was the third largest on the list, the first being sheet brass, 476,186,000 pounds, and the second rods, 279,374,000 pounds.

The output of semifabricated copper products was 753,047,000 pounds, including 3,236,000 pounds of castings. By far the leading item under copper, is wire, 344,124,000 pounds, with castings fifth.

It is estimated by trade authorities, at least so far as rolled brass is concerned, that the output in 1917 was 2 1-3 times as large as the rate of production in the beginning of 1913. In compiling these figures and giving the total consumption of copper for the country, the pamphlet does not make clear whether production from scrap metals was included in the foregoing figures, but as the total of copper used is several hundred thousand pounds less than the combined total given by the geological survey for the domestic consumption of metal and the output of secondary brass and copper, it seems likely that much of the output of brass from collections of scrap, was not included. It would seem probable that the output of many small foundries might be overlooked, and so it is likely the item of brass castings should be larger than the 120,266,000 pounds named. In 1918, for which complete figures are not available, the output of brass and copper products was larger than in 1917, through the urge of war.

Plans Large Addition

Allis-Chalmers Mfg. Co., West Allis, Wis., has broken ground for a large new gray iron foundry in which will be made the castings for a new farm tractor as well as the foundry work of the Reliance plant, located in Milwaukee, which will be moved into the new plant upon its completion about March 1, 1920. A. E. Harrison, is assistant general works manager.

The Lyon Metallic Manufacturing Co. of Aurora, Ill., manufacturer of steel shelving, lockers, boxes, cabinets and general steel equipment, has opened a New England district sales branch in Boston. J. B. Throckmorton who formerly represented the company in New York is in charge, with offices at 161 Devonshire street.

Useful Hints on Electric Welding

To Produce Good Welds Care Must be Used in Cleaning the Break Before Welding — What Equipment is Required — Cast Iron is Difficult to Weld

BY H. L. UNLAND

WELDING of wrought iron or steel in simple sections by the electric arc-welding process presents no serious difficulties if reasonable care on the part of the operator is used in preparing the weld. Welding practice is divided into three steps which deal with the equipment and materials, preparation for welding and the welding operation itself.

In addition to the equipment and auxiliary apparatus, special jobs render it desirable to have on hand other miscellaneous pieces of equipment.

Odd pieces of carbon block or copper are of much assistance as dams in holding the molten metal in place. In cases where the weld must be smooth on one side, a piece of copper or carbon is held against the weld and metal filled against it. Iron or steel can be used if care is taken not to weld to it. In filling a hole, the bottom is often closed by holding a plate of carbon or copper against it until sufficient metal is filled in to hold. Care should be taken to flow the molten metal against the guide pieces and not to allow the arc to play directly on them.

A steel wire scratch brush is used to remove light scale and rust, before commencing to weld if necessary, and also at intervals during the welding, usually when changing electrodes.

For small work the positive lead may be bolted to an iron plate forming the top of a work bench. The work may be set on this bench, the contact being sufficient to carry the current. A convenient terminal for the positive cable consists of a copper hook of proper size to which the cable is bolted. The terminal may be laid on the work or hooked on a projecting part. It is seldom necessary actually to clamp the return lead to the work.

Should Provide Work Screens

If welding is to be done in a room where other employes are working, screens should be provided around the welding operator. They should be high enough to prevent the light striking a large part of the ceiling since the flicker of this light would probably affect the other workmen. White walls and ceiling should be avoided in a welding room.

Gas burners for preheating and fire brick, sand, or sheet asbestos for covering, are useful, especially for cast-iron work, which in many cases should be preheated uniformly to a red heat and welded while at this temperature. A receptacle of water is desirable, in which the electrode holder can be cooled when it becomes too hot after continued use.

Preparing the Weld

Metal that is clean is much more likely to make a good, strong weld. Scale, rust, grease, soot, and foreign matter will contaminate the weld and such inclusions necessarily weaken it or else make it hard. Impurities may also make the metal porous and spongy due to liberation of gas. Pieces of foreign matter may prevent the molten metal filling all parts of the weld and cause cavities. Various methods for cleaning are in use, pickling for small parts, washing with gasoline or lye, boiling with lye, sand blasting, chiseling, scratch brushing, etc., the method depending on the local conditions. In welding heavy sections where it is necessary to deposit several layers of metal, the surface of the preceding layer should always be cleaned before starting the next.

When sections of ⅛-inch or less in thickness are to be joined, the edges need not be beveled but they should be separated a small amount. Thicker sections should have the edges beveled to give a total angle of 60 degrees as well as separated by ⅛-inch. In some special cases angles as low as 30 degrees may be necessary and as high as 90 degrees may be used, but an average safe value is 60 degrees. Still heavier sections may be beveled from both sides and the weld made from both sides. In the latter case a layer should be put on one side and then a layer on the other to prevent warping. The welding of complicated shapes such as fly wheels and some castings may require preheating at certain points to produce initial expansion which will be overcome as the weld cools. In welding cracks in castings, the crack should be chiseled out to get a good bevel, entirely through the plate with ⅛ to 3/16-inch clear opening on the back or to the bottom of the crack in castings or forgings. In boiler work ½-inch holes are sometimes drilled well beyond the ends of the crack and the crack chiseled, beveled and welded.

In welding with the metallic electrode, the arc should be kept short, not over ⅛-inch in length. The current should not be greater than those indicated in the table for the electrode diameter. Excessive current causes burnt or porous metal to be deposited. In welding a seam, the electrode should be moved in a zizzag or circular path advancing along the seam. The metal will adhere only to the surface on the work actually played on by the arc, so care must be used to bring the arc in contact with the whole surface to be welded.

The electrode must be connected to the negative terminal. If the polarity is reversed the arc will be more difficult to maintain and the deposited metal will not be as good as it should be. In starting the arc, the electrode should be just touched to the work and withdrawn immediately to the required distance. If the electrode is held too long in contact it will weld to the work, causing some delay in freeing it and starting over.

Overhead Welding

The operation of welding overhead is the same as in normal welding. The difficulty largely lies in holding the electrode steady in the cramped position usually required. If the arc length is kept constantly short the metal will be successfully deposited, and practice is required to accomplish this. The appearance of an overhead weld is sometimes marred by drops of metal projecting or by uneven thickness of the deposited metal, but this can be overcome by proper manipulation of the electrode. A rest for the arm will sometimes assist the operator to hold the electrode steady.

In the use of the carbon electrode, the holder should grip the electrode from 4 to 5 inches from the end. The electrode for ordinary work should be tapered to a blunt point at the working end to keep the arc from wandering over the end of the electrode. As the

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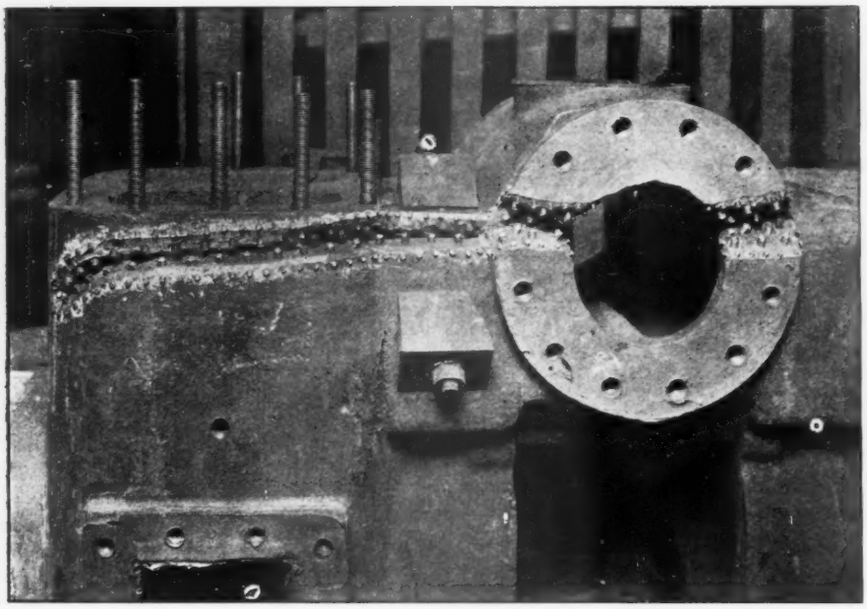


BROKEN CAST-IRON FEED WATER PUMP SHOWING PREPARATION FOR BARE ARC WELDING—THE NUMEROUS STUDS SERVED TO CONFINE THE WELDING MEDIUM WHILE IT WAS IN A MOLTEN STATE

electrode burns away with use, the holder is moved back along the electrode to keep the length of working carbon constant. The burning away of the electrode will tend to keep the taper approximately constant.

The arc is struck in the same manner as with the metallic electrode, but a longer arc should be used, from 1 to 1½ inches being the average. The arc should not be too short when welding or depositing metal as these is danger of depositing carbon in the weld with the probability of a hard weld resulting. In cutting, or melting off metal, the arc should be kept short, about ½-inch being an average length.

Cast iron, due to its properties, is unsatisfactory for welding by any method. Its low strength and brittleness cause it to break from expansion and contraction strains unless precautions are taken, and even then a successful weld cannot be assured. Pieces of simple cross section and heavy pieces present much less difficulty than complicated shapes, but due to the nature of cast iron, care should be used in all cases. The experience and skill of the operator are large factors in determining whether or not a given weld will be successful.

By experimenting, a number of operators have learned to weld copper to copper, copper to brass and steel, and bronze to bronze, as well as monel metal and high-speed steel. The special uses are rather limited in their application and the methods vary, so it is recommended that each operator experiment along the lines suggested by his experience.

Several simple precautions should be observed in the use of electric arc welding equipment, whatever the nature of the apparatus may be. The eyes should be thoroughly protected from the light of the arc. No chinks or holes in the mask should be permitted and the inside of the mask should be painted dull black to prevent reflection of the light from behind.

How Light is Reduced

The colored protective glass should be sufficiently dense to reduce the light intensity to a value not objectionable to the eye and at the same time the definition of the area immediately around the arc should be clear to enable the operator properly to follow the work.

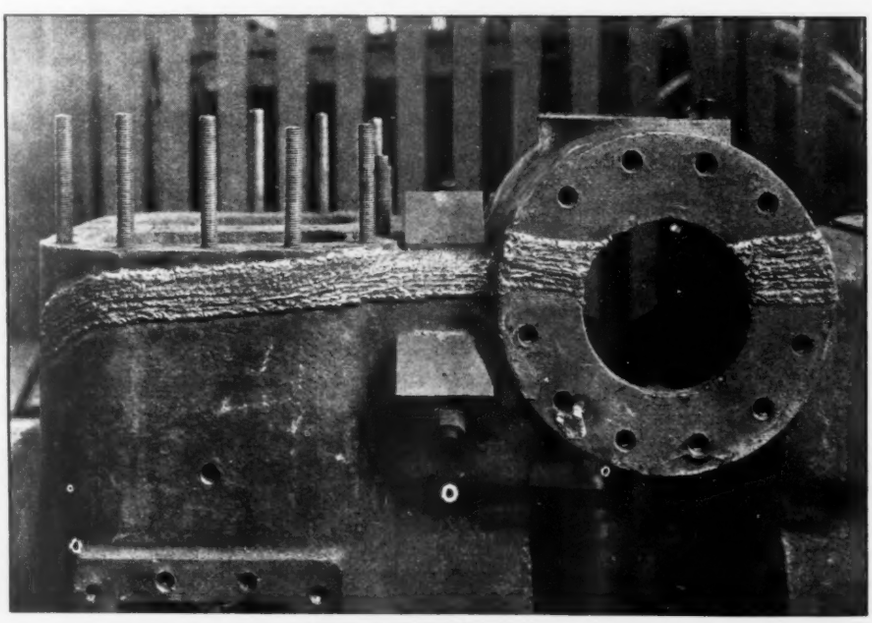
The hand shield is principally used in doing metallic electrode welding. It consists of a light wooden frame with provision for a protective glass window. The protective glass is the same as used in the mask. The shield is also used by inspectors and others who require the protection only for short periods and at infrequent intervals.

The function of the electrode holder is electrically to connect the electrode used to the cable connected to the welding equipment. Carbon electrodes should be rods of hard, homogeneous, uncored and uncoated carbon. The diameter used will vary with the current to be employed. The length depends on the particular class of work to be done. Long carbons reduce the percentage of short ends thrown away, but are more liable to breakage. The average lengths range from 9 to 12 inches.

For welding iron and steel the metallic electrode should be a high grade of low carbon steel wire. A large number of tests were made by the Emergency Fleet corporation to determine the best chemical analysis of wire for this purpose, and the wire now made by a number of manufacturers meets these requirements.

The electrode wire should be cut into pieces convenient for the operation. A length of 18 inches is satisfactory since it is about the greatest length an operator can handle; at the same time it reduces the number of times the electrode is changed, and consequently the wastage, to a minimum.

On account of the intermittent nature of the work it is possible to use smaller



HOW THE CASTING LOOKED AFTER IT WAS WELDED—SEVERAL APPLICATIONS WERE NECESSARY TO FILL THE BREAK COMPLETELY—THE FLANGE AT THE RIGHT IS THE ONLY SURFACE REQUIRING FINISHING

cable for the welding circuits than is standard for the current capacities. In this way, there is also a gain in flexibility which permits better control of the welding arc, by facilitating the manipulation of the electrode holder.

In metallic electrode welding a length of at least 15 feet of extra flexible cable should be connected to the electrode holder to allow the operator to fully control the arc through manipulation of the holder. For the ground or return cable the standard extra flexible apparatus or dynamo cable insulated with varnished cambric for low voltage circuit and covered with double weatherproof braid has been found suitable.

It is difficult to give universally applicable figures covering amperes, speed, etc., for electric arc welding due to the effect of conditions under which the work is done, the character of the work, and to a large extent the skill of the operator. The following figures are based on favorable working conditions and a skilled operator. However, they are approximations given as a guide.

Light work.....25 to 125 amperes
Heavy work.....Up to 225 amperes

Electrode diameter —inches	Amperes	Corresponding plate thickness—inches
1/16	25-50	Up to 3/16
3/32	50-90	Up to 1/4
1/8	80-150	1/8 to 3/8
5/32	125-200	1/4 up
3/16	175-225	3/8 up

The same size electrode may be used with various thicknesses of plate, the heavier plate requiring the use of the heavier currents.

Approximate speeds of welding sheet metal with the metallic electrode are given in the following table:

Thickness of plate	Speed in feet per hour	Cost per foot
1/16	20	2.12
1/8	16	3.12
1/4	10	7.13
3/8	6.5	12.3
1/2	4.3	19.8
3/4	2.0	41.7

The foregoing figures are based on average figures for materials and labor. They will probably vary considerably for different localities and will vary slightly with the type of equipment, but the relative costs of gas and electric welding will in general hold true.

The carbon electrode can be used for welding and for building up metal in a large number of cases where the metal is not subjected to high strains or where it is under compression only. This process can be used to a large extent in rough cutting of plates and structures. The average current ranges for different types of work are as follows:

Light welding, amperes.....150 to 250
Medium welding, amperes.....250 to 350
Heavy welding and medium cutting, amperes.....400 to 600
Very heavy welding and heavy cutting, amperes.....600 to 1000

The maximum values of current permissible for the carbon electrodes are as follows:

Diameter of electrode	Maximum amperes
1/4 inch	100
1/2 inch	300
3/4 inch	500
1 inch	1000

Graphite electrodes permit the use of somewhat higher current densities but the higher cost of graphite electrodes is a factor to be considered. Lower currents than the above may be used, but higher values will result in undue burning of the electrodes. For depositing or building up metal by means of the carbon arc on flat surfaces where the work is accessible and all conditions favorable, the following figures may be used:

Current amperes	Number per hour	Cubic inches per hour
200	1 1/2	5.4
300	3	10.8
400	4 1/2	16.2
500	6	21.6

For continuous work the above figures may be used, but for the short jobs of 10 minutes or less the rate will be double the above.

Recarburizing and Deoxidizing Converter Metal

By H. E. Diller

Question—We would like to know a way to figure the amount of recarburizer necessary to put into converter steel, and whether the usual practice is to add the recarburizer in the solid or molten state. If coke is used to raise the carbon in steel what is the proper amount to use, and how fine must it be ground? What is the correct amount of aluminum to add as a reducing agent? We would also like to know the different methods employed to keep down the sulphur in iron.

Answer—Recarburizers are sometimes added without being previously melted, when the amount of carbon to be added is small. If it is desired to increase the carbon in the steel more than 0.10 per cent, ferromanganese is sometimes added in the lump form and the additional carbon needed is secured by adding molten metal from the cupola. Recarburizers are best added in the molten form. A convenient way to melt them is in a small oil or gas-fired furnace. Spiegeleisen, 80 per cent ferromanganese, pig iron and iron from the cupola are used as recarburizers. They are used singly, or portions of several of them are melted together, depending upon the amount of manganese it is desired to introduce into the metal.

The amount of recarburizer necessary to bring up the carbon in the steel to the percentage desired may be figured as follows: Analyze the different metals in the recarburizer to determine the percentage of carbon in them. Then figure how much carbon is required to raise the carbon in the converter charge 0.01 per cent. This is multiplied by the number of points—0.01 per cent—it is desired to increase the carbon. The per cent of carbon in the recarburizer will depend upon what is used. Suppose it is found that the recarburizer contains 4.4 per cent, or 4.4 pounds of carbon to every 100 pounds of recarburizer. Then for a 2-ton converter charge 100 pounds of recarburizer will add 4 pounds of carbon, or 0.10 per cent, after deducting 10 per cent of the carbon in the recarburizer for loss by oxidation. For every 10 pounds of recarburizer added, the carbon in the steel will, therefore be raised 0.01 per cent. Then 10 pounds of recarburizer must be added for every 0.01 per cent rise in carbon in the steel.

Coke is sometimes used as a recarburizer but gives such irregular results that many foundries have discarded it. When used, it is generally thrown into the ladle in paper bags just before the steel is poured from the converter. The coke should be approximately pea-size or powdered. The amount can only be determined through practice, as the portion going into the steel will vary considerably, according to the way it is handled.

We believe that as little aluminum as possible to accomplish final deoxidation of the steel should be added. The exact amount would be decided by the results obtained. Some foundries have substituted ferretitanium for aluminum. Other foundries place small pieces of aluminum in the molds, near the gate, to deoxidize the steel which may become oxidized during the pouring.

About the best way to keep down the sulphur in iron melted in a cupola is to use low-sulphur stock and melt with low-sulphur fuel—either a low-sulphur coke or with oil. Melting fast and hot will help to a limited extent.

German zinc foundries are endeavoring to effect an increase in the prices of zinc, in spite of the refusal of the government departments, on the ground that the prime costs are hardly met by the present prices. The position of the zinc industry is so particularly difficult because of large stocks from the war over-production.

The alloy works at Tyssedal, Norway, which were closed down some time ago on account of financial failure, have been let to the Norwegian Electro-Chemical Co., which intends to manufacture ferromanganese. The raw material will be procured from the south of Russia.

Builds Novel Foundry for Making Railway Brasses

Design is Influenced by Considerations of Economical Operation and Comfort for Employes

CAREFUL consideration for the comfort and welfare of employes and a systematic arrangement of equipment to develop high economy of operation in a foundry forming a very considerable unit in the total plant of an organization, too often is neglected where the foundry plays a less conspicuous part. However, these factors governed in the construction of the brass foundry of the Chesapeake & Ohio railroad at its Huntington shops, Huntington, W. Va. This shop, now being reconstructed and enlarged throughout, is the principal plant for repairs and maintenance on rolling stock for the road, which owns 923 locomotives, 395 passenger train cars and practically 50,000 freight train cars. The plant was designed by the motive power department of the railroad assisted by the Arnold Co., Chicago.

The brass foundry at this plant provides not only all bearing brasses and linings and all the various red and yellow brass parts for such repairs but also produces the same for all other points on the system where minor repairs are made. The present daily production includes six tons of car and locomotive bearing brasses and similar parts, ranging in weight from 400 pounds to a few ounces each, and six tons of miscellaneous red and yellow brass castings. It was deemed desirable in laying out the foundry to provide for an increased production of not less than 50 per cent.

The new foundry building extends east and west, is 57 x 243 feet, with a clearance below the truss line of 15 feet. On the west end is a coke bin 17 x 49 feet, and on the south side a rattler room, 12 x 32 feet. The foundations, side and end walls to a line 3 feet 6 inches above the floor, are concrete with common red brick above. The roof is supported by steel trusses spanning the entire width of the building and spaced 20 feet center to center and provided with saw tooth monitors spanning three-quarters of the width of the building.

The roof sheathing is concrete tile laid in slabs approximately 5½ x 2 feet and 2 inches thick, covered with a four-ply built-up asphalt roofing.

All sash is steel. The side wall sash is glazed with ⅛-inch rough glass, installed smooth side out, and the hinged continuous monitor sash which is operated by hand from the floor is glazed with ¼-inch rough glass. Thirty-seven per cent of the south and 25 per cent of the north wall area is pivoted for ventilation.

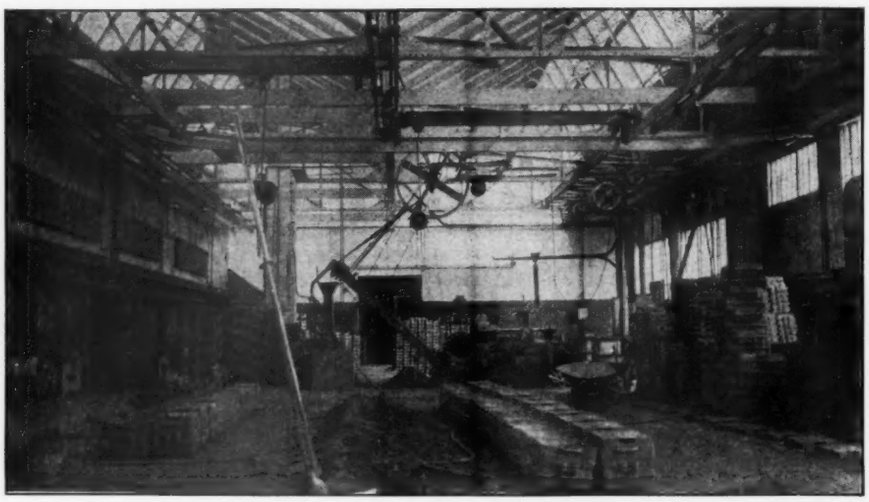


FIG. 1—GENERAL VIEW OF MAIN MOLDING FLOOR OF THE CHESAPEAKE & OHIO BRASS FOUNDRY AT HUNTINGTON, W. VA.

Artificial light is supplied by a system of 200-watt electric lamps with 14-inch enameled steel reflectors located at the truss line and so distributed that each unit illuminates approximately 300 square feet of floor area. The building is heated by a gravity return steam system, using cast iron wall radiators.

The east bay of the building is devoted to storage for completed castings awaiting delivering, has a concrete floor and is equipped with a two-ton dial type platform scale. In one corner of this room and separated from it by a steel and wire partition is the foreman's office. This bay has a second floor above devoted to pattern storage and the entire bay is separated from the remainder of the foundry by a 13-inch brick fire wall.

Extending westward from the storeroom along the north wall for four bays are a series of concrete bins for storage of metals used in making car brasses and linings. Access to these bins from outside the building is provided by a series of hatches in the outer wall so that material may be unloaded from cars on the siding which extends the entire length of the building on the north side, directly into the bins. From the inside, access is obtained by a steel door in each bin, so hung as to swing into the bin and provided with an open hatch so that should the bin be too full to allow the doors to be opened material may be obtained through the hatch..

Immediately above these bins is a gallery provided with complete toilet, locker and washroom facilities, including shower baths. This gallery is divided into two sections, one for white and one for colored employes.

Along the wall in the next two bays are the tilting furnaces referred to later, and in the succeeding four bays are a series of bins, similar to those already described, which are used for sand storage and for the red and yellow brass metals.

Along the west wall and extending across the building for a distance of about 20 feet is a battery of eight

coke-fired crucible pits flanked on the north by a mold-drying oven, 18 x 11 feet, and on the south by a drawer-type core oven.

The arrangement of the smoke and gas flues from the crucibles is such that the hot waste gases may be passed through the mold oven for drying large molds or preheating crucibles, they may be directed through the core oven, or may be passed to the concrete stack outside the building. Provision also is made to divert the gases through the heating boiler. In normal operation when only about one-half of the crucibles are in service, all waste gases are diverted to the core oven during the major portion of the day and to the mold oven after the day's pour is off and the pits are burning out. In this way it is found that the core oven is entirely heated by waste gases and the mold oven is kept at a sufficient temperature properly to cure crucibles. Auxiliary burners for natural gas are provided to supplement the waste gases as required.

The division of the product of this foundry between the bearing brasses and the red and yellow brass castings results in two molding and casting divisions of the foundry which are practically distinct.

Three bays of the main floor west of the finished stock room are used for chipping and grinding castings and for finishing and lining the bearing

FIG. 2—SIDE OF THE MOLDING FLOOR SHOWING CORE OVENS AND LOCATION OF CRUCIBLE FURNACES

brasses. This portion has an area of approximately 3000 square feet and is floored with concrete. The next three bays to the west are used as a molding floor for bearing brasses. The next four bays, having an area of 4000 square feet, serve as a molding floor for red and yellow brass castings. Each molding division is served by a ½-ton beam crane, which is used for pouring and handling castings.

A 1-ton electric monorail hoist serves the entire length of the shop in front of the storage bins and in front of the crucible pit while a loop track across the shop in front of the tilting furnaces, thence east along the south wall and thence back across the shop at the east end of the mold floors still further extends its scope of operation. By this system, raw material may be delivered from the storage bins either to the tilting furnaces or the crucibles and castings may be delivered to the rattler room and machining floor. A scale near the crucibles and integral with the monorail is used to weigh raw materials while a platform scale is set adjacent to the tilting furnaces and serves them.

The crucible pits located as noted at the extreme west end of the building, are supplied with coke from the bin just outside with a minimum rehandling. Raw material is brought to the crucibles and deposited in containers immediately in front of them, from whence it is fed to the crucibles as required. A jib crane, with air hoist, attached to the west wall is used to withdraw heated crucibles and to place them in either one of the three skimming pockets located one under each crane serving the mold floor, from which the crucible is picked up directly by the crane without rehandling. The crucibles are poured while thus suspended.

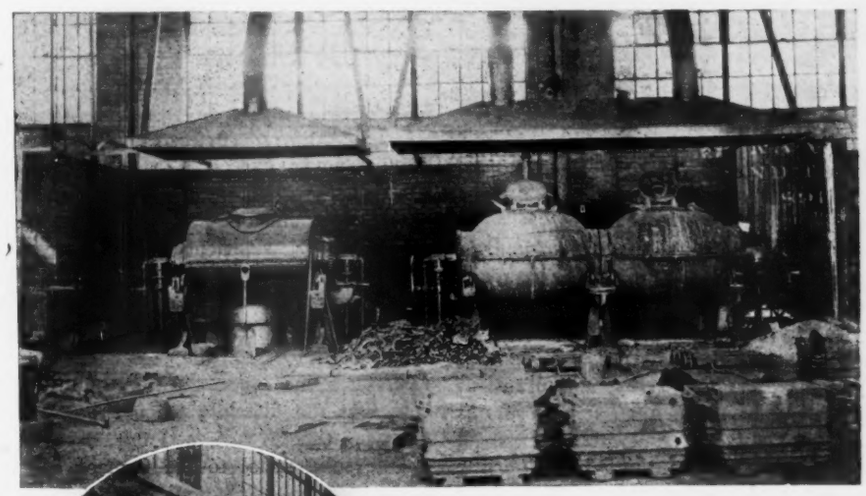


FIG. 3—BATTERY OF TILTING TYPE NONFERROUS FURNACES USED FOR MELTING BEARING BRASSES

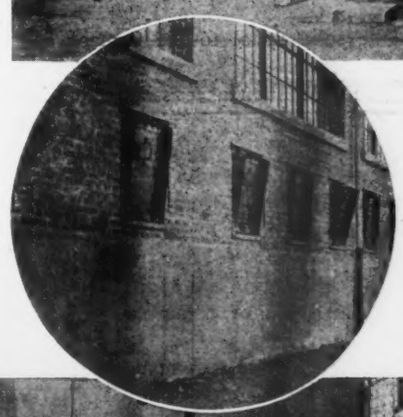


FIG. 4—HATCH SYSTEM FOR DELIVERING MATERIALS FROM THE RAILWAY CAR TO THE STORAGE BINS

As soon as they are shaken out castings are collected into containers and delivered by the cranes to the monorail at the east end of the mold floor division and thence transferred to the rattler room. From the rattler room, castings pass directly to the sprue cutter and grinders located along the south wall just east of the rattler room.

Each grinding wheel is provided with a dust hood and collector box for heavy particles and connected to an exhaust system with a collector. The exhaust fan is located beyond the collector so that the abrasive particles are not drawn through it.

Equipment for melting bearing brasses consists of one double chamber furnace of 2000 pounds capacity and one single furnace of 1000 pounds capacity, fired by natural gas. Air for them is furnished by a positive

blower installed immediately adjacent with the ladle heaters on the other side. Ladles of molten metal are conveyed by the monorail to either of the two cranes serving the mold floor. Castings are collected and transferred to the rattler room and thence to the grinders. From the grinders these castings go to the boring lathe nearby and thence to the babbitting furnace, the trimming lathe and to stock room for shipment.

How and Why in Brass Founding

By Charles Vickers

Preventing Oxidation of Brass Alloys

We have lately experienced an unusual amount of trouble in making sound brass castings. The trouble is caused by porosity. We sometimes use ingot brass exclusively, sometimes a mixture of ingot brass and scrap, and occasionally all scrap. When all ingot brass is used we have less trouble than when all scrap is used. We think our difficulty is due to oxidation, therefore, we use charcoal and phosphor tin or phosphor copper. The phosphorus, however, liquifies the metal to the extent that it penetrates the cores and we get very rough castings. Therefore, we would like to learn of some coating to place on the cores to prevent this penetration.

To cure this condition of porosity, first give additional attention to melting the metal. Also use deepeners on the crucibles. These are made by cutting off the bottom of old crucibles. They should be placed on top of the crucibles to form hoppers, and then filled with metal. The deepener acts as a protection to the metal before it sinks down in a molten state, as it keeps the furnace gases away from the metal and allows more to be filled in cold. Also use the following flux: Take ½ pail of sawdust or fine charcoal and mix with it a quart of sharp sand and a quart of lime. In another pail mix a can of common lye with 2 quarts of water. Add the lye water to the sawdust or charcoal and mix. If there is not sufficient water, to make the sawdust thoroughly damp, without dripping water, add more. Use about a pint can full of this flux to a pot, placing it on top of the cold metal. If the slag is too fluid to skim off, add sand to thicken it. It is always better not to skim the metal before it reaches the floor where the molds are to be poured.

Either phosphor tin or phosphor copper will produce rough castings when too much is added to the melt. The amount of phosphorus that should be added to red brass is very small; it should never exceed 0.25 per cent of phosphor copper containing 15 per cent phosphorus, and one-half of this amount is generally sufficient to thoroughly deoxidize. The reason scrap metal makes poorer castings than ingot metal is that before melting it exposes a larger surface to the furnace gases than does the ingot. This would indicate that the difficulty originates in the furnace, that it arises from exposure of the solid metal to the furnace gases which contain sulphur dioxide and free oxygen. As soon as possible, therefore, after melting commences the metal uncovered should be poked down to get it out of contact with the gases. If hot sand is being used in making the molds, the latter should not be closed until ready for pouring, in order to avoid condensation of moisture on the cores and walls of the mold.

Making Nickel Castings

Some time ago we made a number of nickel castings that were fine but since then we have been unable to obtain one that was not spongy. We are using the same metal as before, and melt in a coke-fired furnace. The sand we use is ordinary brass sand, and we have tried pouring the nickel at various temperatures with the same results.

The nickel castings are spongy because no deoxidizer is used; the first castings were sound because the nickel absorbed carbon and became carburized owing to some difference in melting, or to the presence of coke in the crucible. Nickel is similar to iron in its relations to carbon; melted in a carbon crucible it will absorb carbon until it resembles cast iron, and it can be cast about as easily. In order to remove the source of the blowholes some deoxidizer must be added, such for instance as one pound of 10 per cent magnesium copper, for each 100 pounds of nickel. The magnesium should be added just previous to taking the nickel from the furnace. Silicon also may be used as a "deoxidizer," in fact any alloy found good for making solid copper castings can be added with advantage in making nickel castings.

Art Bronze Castings

We are making ornamental bronze castings about ⅛ inch thick, and we frequently find pin holes on finishing a flat surface. At other times the metal is separated so that a knife could be inserted and split it into two plates. It seems to us this splitting is caused by a gas of some sort, and we wonder if it is due to pouring the metal too hot? The alloy contains copper, 90 per cent; tin, 6 per cent, and zinc, 4 per cent. Can you inform us as to the cause of this difficulty?

If the porosity occurs only locally and in connection with the flat parts of the casting, it may be caused by steaming of the mold while it is waiting to be poured. If the molds are thinly skin dried and are then closed and allowed to stand before the metal is poured into them, the heated film of sand will take up moisture from the backing and will steam, filling the mold cavity with moisture which ultimately condenses on the mold surfaces and results in local porosity. The remedy is to thoroughly skin-dry the molds so as to have them warm when the metal is poured into them. Superficial skin-drying is likely to do more harm than good and is consequently labor lost.

It is not likely that the splitting of the brass into two plates is caused by gas as there is no reason why, if much gas was present, it would assume a position in the center of the metal thickness. The splitting is due to shrinkage which may be traced either to a lack of eutectic in the metal itself, or to the proximity of a comparatively heavy section of metal, but at a lower level in the mold, which drained the eutectic from the heart of the thin section. The metal solidifies from the sand surfaces inwards. In a casting of uniform thickness, if the alloy is lacking in eutectic, it is conceivable that all the available metal might be converted into crystals attached to the cooling surfaces and thus leave a vacancy between the upper and the lower surfaces of crystals. When the metal at the sides was cut

away this vacancy would be revealed as a thin line of demarkation, and when a tool was inserted into the crevice the casting could be split into two plates.

If the casting is not of uniform thickness, the same result may be obtained even when the alloy has abundant eutectic to fill the space between the two layers of crystals, if this eutectic can drain by gravity to another part of the casting. It will drain by gravity, provided openings are made by shrinkage, at a lower level of the casting, with which eutectic from the higher level can connect. The result is two layers of crystals superimposed, but not adhering; because they had hardened out of contact with each other and hardened metal surfaces will not cement together, as the cementing must be done while the metal is plastic.

To remedy this condition, if there are contiguous thin and thick sections; place feeders on the thick section to supply metal to them so they will not draw on the interior of the thin sections. If the casting is of uniform thickness, change the alloy. An alloy of the following composition would be worth a trial: Copper, 88.50 per cent; tin, 5.50 per cent; zinc, 3.50 per cent; lead, 2.50 per cent. This alloy would be plenty strong enough for ornamental castings and it would cut much better than the alloy now being used.

Method of Recovering Lead From Dross

Would you please inform us how we can recover the metal from battery lead, and from lead dross?

The metal cannot be recovered from battery plates or from lead dross by melting the material in a crucible, as the lead salts eat up the melting vessel and destroy it in one operation. The material must be handled in reverberatory and blast furnaces. The first operation would be to recover as much metallic lead as possible by liquation; that is by heating the charge on an inclined hearth in a reverberatory furnace until the metal melts and runs out of the furnace. The residue, consisting of lead oxides and sulphate, should be smelted with iron in a blast furnace, but if this is not available it may be treated in the reverberatory by thoroughly mixing it with an equal amount of a flux consisting of glass, 6 pounds; salt, 3 pounds; fine coal, 4 pounds; and divided iron scrap, 10 pounds. The iron may be in the shape of borings. Mix this flux thoroughly with the residue from the liquation process, charge it into the furnace and heat to a little over 1000 degrees Fahr. The temperature must not go over 1500 degrees.

Pin Holes in Aluminum Castings

We have experienced difficulty in making aluminum castings shaped like a ring, thin in section, one side rounded the other channeled out, with little bosses the size of a lead pencil tip spaced centrally on the channeled side. The difficulty is caused by the presence of small pin holes clustered together and by small irregular-shaped pockets on the drag side of the casting, which is the convex side. These pockets appear to be similar to the effects produced by hard ramming the sand in the case of iron castings. We pour at 1260 to 1280 degrees Fahr. Any information you may be able to give us will be appreciated.

The defects attributed to pin holes are not due to gas; they are simply depressions produced in the casting by the presence of some loose material that has collected while the mold was being poured. The facing that is dusted on the mold may cause them. No doubt the molders dust parting on the molds to finish them and this parting failing to adhere when the aluminum runs over it is washed off and eddied to some other part of the casting. If it is not due to this cause it is due to loose sand. Greater care should be taken to clean the mold before closing, as every little grain of sand leaves an indelible mark on the white metal. The depressions on the drag part of the casting may be due to gas or to shrinkage; most probably gas. To eliminate the possibility of shrinkage being the cause, place small, but relatively heavy bosses in the cope and gate them to the casting as feeders. Try a few molds and examine the castings for the depressions. If this eliminates the depressions, the use of a heavier gate, combined with a higher head of metal is indicated. If due to gas, spray with molasses water, dust on parting and blow off when finishing the molds, then just before pouring, skin-dry the molds with a gasoline torch, then close and pour. If this cures the trouble, it is possible soft ramming drag, and venting will give good castings in green sand.

Corrosion Resisting Bronze

We have experienced considerable difficulty in getting brass or bronze that will withstand mine waters and we would like you to suggest mixtures suitable for water of the following analysis: Water No. 1; contains; silica, 1.63; oxides of iron and alumina, 19.70; calcium sulphate, 25.87; magnesium sulphate, 20.18; calcium carbonate, 3.90; sodium sulphate, 16.10 grains per U. S. gallon. No. 2, contains; silica, 21.79; oxides of iron and alumina, 24.11; calcium sulphate, 101.46; magnesium sulphate, 2.77; sodium sulphate, 28.52, and magnesium carbonate, 12.70 grains per U. S. gallon.

While ordinary yellow metals and brass containing zinc do not appear to withstand mine waters well, manganese bronze which ought to contain about 40 per cent zinc is very successful, especially in the hard coal mine waters of Pennsylvania. Probably this is due to its fine grain as fine grained metals withstand corrosive influences best. If manganese bronze can be used in this situation we suggest a trial, but the alloy should be of good grade and not the material often passed as manganese bronze and which is simply a yellow metal of uncertain composition, containing aluminum. If manganese bronze cannot be used, we suggest the following alloy as suitable for No. 1 water: Copper, 85 per cent; tin, 5 per cent; 5 per cent phosphor tin, 5 per cent, and lead, 5 per cent. For No. 2, a harder alloy would probably be more satisfactory, and if the following alloy can be cast without difficulty it will give good service: Copper, 73.50 per cent; 15 per cent phosphor copper, 7 per cent; tin, 12 per cent, and lead 7.50 per cent. The alloy is difficult to cast and get sound castings. It must be poured at a low temperature, and be well fed with risers. The latter alloy might be replaced by the following: Copper, 88.50 per cent; 30 per cent manganese copper, 0.5 per cent; tin, 11 per cent. This alloy could be used for both waters.

Carburetor Core Mixtures

We would like to obtain a suitable core mixture for valves and curburetors. We are using a dextrine and starch product as a binder.

A satisfactory core can be made from sharp sand, 3 parts; molding sand, 1 part, mixed with the above binder in the proportion of one part of binder to 25 parts of mixed sand. If an oil binder is preferred, the following mixture makes a good core: Molding sand, 5 pounds; sharp sand, preferably silica sand, 7 pounds, weighed dry, mixed and tempered with water after which 6 ounces of core oil should be added.

To get clean castings, have the molds perfectly free from all loose sand and warm the cores. It is preferable to wait with coring until a few minutes before the molds are poured, then to place the warm cores, close the molds and pour immediately. If the cores are allowed to stand in the molds for several hours as is often done, they will either absorb moisture and be softened, allowing the sand to wash or the cores to blow.

Castings for Ship Construction-XV

Pattern for Special Stern Frame May be Made in Two Ways Involving a Shell Pattern or Solid Pattern With Coreboxes—Circumstances That Determine Type Used Are Outlined

BY BEN SHAW AND JAMES EDGAR

STERN frames and stem pieces resemble in that they are long and narrow, and in section are practically the same, but stern frames are much more elaborate and more subject to damage than stem pieces. The similarity in cross section is of course because these two castings define the shape of the vessel fore and aft respectively, and the plating is riveted to them. The design of some stern frames is a flat plate instead of trough section. The latter is stronger, and is better because the plating is more outlined. For the reasons given it is apparent why stern posts or frames if they are large are made in two pieces. To replace a broken stern frame is an awkward job, and the cost is great and although the foundryman cannot remedy a bad design, he should see that the best possible casting is made. In this article small types of frames will be considered.

The frame of which a front and end elevation, a plan, and two cross sections, are shown in Figs. 1 to 5 is a type sometimes used on small warships. From for the plating is usually about ½ inch deep, and it may be mentioned that no chipping or machining is allowed care being taken that the molder does not leave a fillet. The stopper, Fig. 4, is to prevent the rudder swinging too far around. The rudder post of course goes thtrough the boss *C*. A clear understanding of the operation of the stopper and the position of the rudder casting in relation to the stern frame will be obtained by referring to the rudder pattern described in the May 1 issue of THE FOUNDRY. This rudder and the

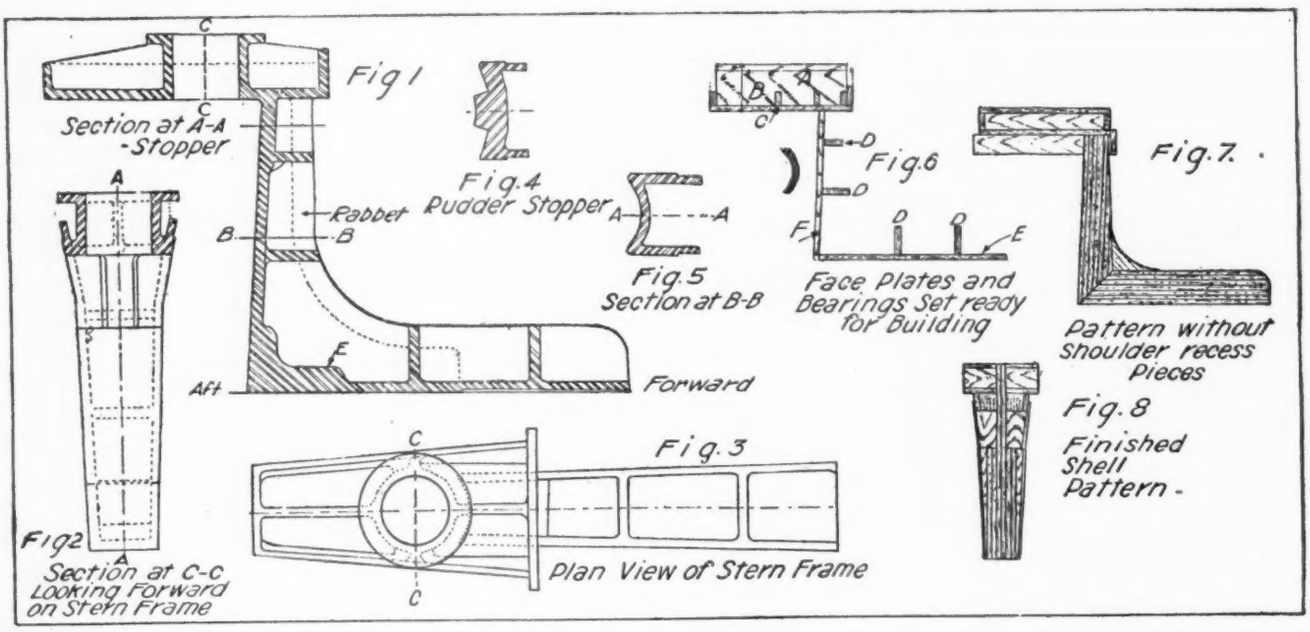


FIG. 1—SPECIAL SMALL STERN FRAME CASTING FIG. 2—SECTION OF STERN FRAME ON LINE *C-C*, FIG. 1 FIG. 3—PLAN VIEW OF STERN FRAME FIG. 4—RUDDER STOPPER FIG. 5—SECTION ON *B-B*, FIG. 1 FIG. 6—FACE PLATE AND BEARINGS SET READY FOR BUILDING STERN FRAME PATTERN FIG. 7—PATTERN WITHOUT SHOULDER RECESS PIECES FIG. 8—FINISHED SHELL PATTERN

easily riveted on the frame and short rivets can be used.

The importance of securing an almost perfect casting for the stern frame is readily appreciated, as apart from defining the shape of the stern, its chief function is to give support to the rudder. The propeller brackets also often rest on the stern frame. Thus it has to bear the strain and weight of the propellers and the tail shaft. If a ship is more heavily loaded at the stern and she touches bottom, it is the aft end of the stern frame that first feels the impact, and it is not unusual for it to be broken. In previous articles the advantages accruing from making two castings instead of one large casting were Figs. 2 and 3 it will be seen that both legs of the casting converge towards one point but the trough cross sections show that the plates on the top and bottom are parallel, and do not form flat surfaces. The design is probably easier for the patternmaker than when the channel becomes wider at the open side. Two methods of constructing the pattern will be described, the one requiring a block pattern and coreboxes, and the other a shell pattern. When detailing the shell pattern the irregular shape will be used and the pattern constructed accordingly.

The *rabbet* which is shown by the dotted line in Fig. 1 is seen clearly raised in Fig. 2. This rabbet which is stern frame mentioned here were made for the same ship. The increased thickness of metal in the corner *E*, Fig. 1, besides strengthening the casting is valuable when making a shell pattern, in holding it together.

Several difficulties present themselves in constructing the pattern. It must be decided whether the circled face which gives clearance for the rudder post has to be cored off, or made to the correct shape. As the shell pattern is adopted, it is well to construct it to the shape of the casting, and let the molder make a drawback. However, because of the difficulty in cutting the shape, the extra trouble to the molder, and the ease with which a core can be set into the

drawback, the best way of dealing with the stopper shape is to screw on a shallow print and make a corebox. It is possible to make it without a core, and some molders prefer this method rather than be troubled with a core; but the print and corebox is less troublesome. Although in the sketches no print is shown on the inner side, the formation of the circular core through the boss is a matter for arrangement with the foundry, and in all probability the molder would want a core, as chaplets are not satisfactory for such a job.

The most difficult part of this casting is the top. It could be made as a shell, but this would give the molder trouble, and as the shape is comparatively regular, it is much better to box it and provide cores. In this article the top will be boxed and consequently the difference between the two forms of construction is in the legs. A template is supplied by the molding loft to define the front elevation, Fig. 1, and another is sent down for the trough sections. Although this is not a large job and could quite well be laid out on a drawing board on trestles, it is not necessary to do so. Like stem pieces and shaft brackets the lines are laid out on the building floor that the pattern may be accurately built, and while cross sections should be drawn, yet when the floor drawing is covered the sizes of details can be lifted from the blue print or tracing, and if necessary a scrap view may be made on a small board. This would be advisable when making the corebox for the top core with the circular boss.

A plate should be planed and placed on the floor upon which the print for the top core is built. This plate should be the total length (*A*, Fig. 6) and the full width (*B*, Fig. 6). The print need not be more than 1¼ inch thick and although it is not shown as thus in the sketch it is better to make it a half lapped frame. The width depends on core bearing at *C*, Fig. 1, and should be at least three or four inches. Boxes are built for the prints, and it will be observed from Fig. 8 that they are much deeper than the pattern. This is necessitated because of the large diameter of the branch flange. While a shallower print, say from the inside of the metal might suffice, still there is objection to having a part of the flange in the corebox and a part on the print. It also is simpler to make a parallel box for the print than to follow the shape of the metal. The print should be made deep enough to allow two or three inches of sand outside the flange. In boxing up the prints the ends should be checked into the sides; and the top, instead of covering the sides and ends, should be fitted inside resting on a recess or shoulder.

Fig. 6 is a view of the skeleton of the pattern before the covering plates have been built on, the prints not being shown. When the plate *C* is screwed in position, bearings as shown have to be fitted against it and then the bearings *D, D, D, D* set in position. As the bottom piece *E*, Fig. 6, will serve as a bearing when constructing the circular face, it should be laid down next. There is really only one way of making the face piece *F*, Fig. 6, and that is to build in layers using 1½-inch lumber. It may be convenient to use a few temporary bearings to get the correct shape of the face. Each thickness as it is placed should be bedded against the bearings, after which they should be planed through and the thickness gaged, that the outer face may be planed. When the full depth has been built it will be necessary to lift the piece on to a bench and smooth away irregularities on the surfaces. The pieces should be pocket screwed to the piece *C* after which the covering plates may be made, the building being similar to the building of stem pieces. Glue must not be put on the first pieces built, which rest on *F* and *E*, as the whole plate will have to be lifted after it is built, to be finished between the bearings and brought to thickness. In Fig. 7 this covering plate is shown with a mitered joint. It is awkward to built it so that the joints of each course will overlap the joints of the previous course laid down, so dependence must be placed upon careful jointing. If a number of ships are being built, and consequently the pattern will have to be used many times, it is wise to set a diagonal hardwood piece as suggested by the dotted lines (Fig. 7). It will be noticed that the cover plate is carried right against the top print which enables it to be well screwed to the piece *C*, Fig. 6, and also to the bearings which determine the shape of the top trough. The mitered joint should not be glued while building as the finishing would be complicated. The plates are much more easily cleaned in the inside with crank gouges and a short plane if they can be worked through from end to end, but the outside can be as easily finished when both plates are fastened together. The top cover plate is shown as being made of one thickness in

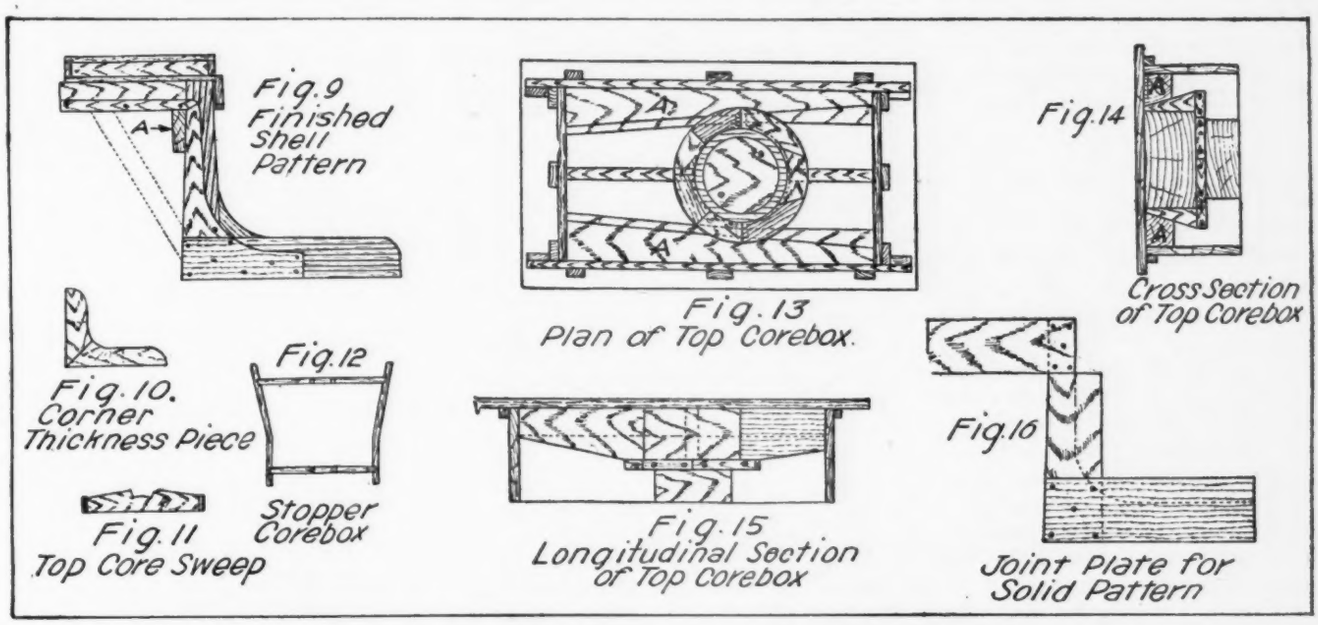


FIG. 9—SIDE VIEW OF FINISHED SHELL PATTERN FOR STERN FRAME FIG. 10—CORNER THICKNESS PIECE FIG. 11—SWEEP FOR CORE FIG. 12—STOPPER COREBOX FIG. 13—PLAN OF TOP COREBOX FIG. 14—SECTION OF TOP COREBOX FIG. 15—LONGITUDINAL SECTION OF TOP COREBOX FIG. 16—JOINT PLATE FOR SOLID PATTERN

Fig. 7, but if the face were not flat the cover plate would have to be built like the other plates.

The print for the stopper *A*, Fig. 10, should be carefully fitted because if it is so made, it will be an additional strength in preventing the pattern from breaking. It may be noted that the ½-inch thickness Fig. 9, is not mitered at the bottom corner like the main plate, the object being of course to bind the miter joint. At the top the corner is mitered, because of its narrowness, and also because as the main plate is carried through to the print no benefit would accrue from making a right angle joint. Sometimes, and especially if the face is twisted, the plate is built to the greater thickness, and the shoulder cut with gouges and planes afterwards. This is a long and laborious task however, if the shoulder is wide, and in a job such as we are considering where some dependence is placed on the extra thickness for strengthening the work, it would not be good practice. If the face were not flat the better method would be to build an extra thickness overlapping the mitered joint, or to bed down a piece of thick wood and cut it to thickness afterwards.

Build for Strength

An important part of the pattern is the extra corner thickness which is shown in Fig. 9. It should be built in thicknesses or laminated and well jointed. When it has been built the two straight edges have to be planed, and the corner sawed on the band saw and gouged and chiseled to the required shape.

Great care should be taken that this piece beds well on the plates *F* and *E* as otherwise when it is screwed on the pattern will be pulled out of shape. An extra thickness also should be fitted towards the top of the post (across *AA*, Fig. 1), but it is easy to draw this piece off and screw it on.

It may be advisable to fit a temporary stay as shown by the dotted lines in Fig. 9, between the top and the vertical post to keep the pattern rigid when turning it over to build the other half on top. This stay may be left on until the pattern is in the sand, presuming that is, that the two halves have not been built on the floor at the same time. Apart from the question of whether it is wise when making such a pattern not to build one half on top of the other, it is not often that there is sufficient floor space if the pattern is large, to do so.

Building the top half is similar to building the bottom, except that the half bearings *D, D, D, D*, Fig. 6, should be battened to the bottom halves. Of course these bearings are ribs, and they should be so screwed between the plates that they can be loosened and pulled out of the drawbacks. The top half should be dowelled through the top flat plate, on which the print sits and also on the edges of plates *F* and *E*, Fig. 6. Many dowels are often a nuisance, but to make sure there is no fin caused through the top half overlapping the bottom half of the pattern there should be two dowels in each of the plates *F* and *E* and two through the flat plate.

Although the plate *A*, Fig. 7, on the bottom half is screwed permanently in its position, on the top half the screws should be easily accessible to the molder as he will remove them to get away the main drawback. It is well to dowel this plate in position so that it can easily be replaced each time the pattern is used. With a stay fitted as in the bottom half, between the top and the vertical post, the pattern is complete. When the prints are being painted the top side should be indicated in order that there may be no danger of the molder laying the permanently fixed plate *A*, Fig. 7, down in the mold. Fig. 8 is a view of the finished pattern looking in the direction of arrow in Fig. 9.

Two coreboxes are required for this shell pattern. These are a stopper box and one for the top trough section with the boss and ribs in. The corebox for the stopper is illustrated in Figs. 11 and 12. It consists of sides and ends. The sides are cut to the shape which is obtained from Fig. 2, and the ends, which will not be square, from the bottom edge of the sides. The core and ends of the print are parallel with the face of the large print. If the ends are cut to the exact shape of the core, a straight edge may be used by the molder for striking off the top, or if the distance *A*, Fig. 11, is short it is better to make the top edge of the ends straight across as shown by the dotted line and plane a piece of lumber to slip between the ends supported by a long batten dowelled on the edges of the ends.

Making the Top Core

The top core is more difficult to make than the stopper core. The molder probably will want this core in two or more pieces for convenience, but if the patternmaker makes it all in one box he can divide with paper or tin as he wishes. The molder often prefers to have a complicated core which must be divided into several portions in the one box, because it enables him to see at a glance what is wanted and assists him when making the cores.

It is necessary to make a bottom for this corebox and as the molder will want to dismantle the box to get the core out the ends and sides should be fastened to the bottom by means of blocks, Fig. 13. The length and width of the inside of the box are determined by the print and the depth is the distance from the face of the print to the inside of the metal and is obtained from Fig. 1. Blocks *AA*, Fig. 13 and 14, have to be shaped for the sides of the core. If the shape is drawn on both top and bottom, these pieces may be sawed to near the line and finished with planes. They should be screwed to the sides of the box, with no screws into the bottom. The center boss should be made solid if it is small, but if it is more than 12 inches in diameter it should be built of segments about 1½ inches thick. As it will be necessary for the molder to draw the flange out of the core into the recess left by the boss, the boss should be built to the face of the flange, and the flange fitted on in five or six pieces with a key piece *B*, Fig. 13. The key piece is the first drawn. The ribs are easily fitted and they also should be screwed in place, so that they can be loosened and drawn from the mold afterward. Of course the circular print is kept flush with the top of the box. Figs. 13, 14 and 15 will make the construction of the box clear.

Making the Block Pattern

Two joint plates similar to that shown in Fig. 16 are made for a block pattern. These should not be less than 1½ inches thick in order that they may be sufficiently strong to support the remainder of the pattern. It will be noticed that these half lapped plates are made to the faces of the prints and the method of joining the plates *A* and *B*, Fig. 17 stiffens the joint plates. The method consists in gouging a line on the center of the plates and sawing out a thickness of plate on each for half the width, so that one plate slips into the other at the required angle. It will be necessary to cut one of the plates of the top print to allow the plate *B* to pass through. The top print and indeed the whole of the top part of the pattern should be constructed in the same way as for the shell pattern.

There is a choice of two methods for boxing up the vertical post and the bottom horizontal piece. Either the shape of the pattern may be boxed or the boxing may be to the face of the print and the inside of the metal, plates being screwed on the boxes afterward to form the shape of the metal. This is no gain from making the prints separately and entails a great deal of extra labor. It is much more practical to box up to face of the prints. Bearings which are shown in Fig. 17 should be made on which to screw the front and top plates. These should be about 2 inches thick. The top plates are shown mitered in the sketch. This is not essential, although it is probably better if the surface of

the plates have to be finished after being screwed on, and of course mitering prevents end and side grains from being on the same face. The patternmaker should always guard against adjacent end and side grain, as the pattern always delivers better from the sand when faces are either all side or all end grain. In the upright post two bearings should be screwed together because of the break in the shape. If the front plate at *A*, Fig. 19, is carried through to the bottom plate of metal, and the front plate at *B* fitted against it the joint plate will be well strengthened. Probably the strongest job is obtained by checking the one into the other in similar fashion to the pieces *A* and *B*, Fig. 17.

The concave face on the inside of the upright post is yet to be made. The joint plates and the piece *B*, Fig. 17, should have been kept back 1 inch or so from the point *A*, Fig. 5, and now blocks planed out and gouged to the section at *AA*, Fig. 1, should be screwed on the face, the object being that the molder can unscrew those pieces and draw them into the mold. The alternative method would be to core off the face which would be clumsy and give the molders needless work, and the other is to box up to the finished shape and force the molder to make a drawback for the concave face. By making the loose pieces he can either use a drawback and draw them in although it is almost certain that no drawback would be made, as no advantage would be gained from making one. Fig. 19 is the front elevation of a finished solid pattern, the top thin plate which forms the rebate being left off, and as in the shell pattern no circular print is shown on the inside although one would probably be used in molding the job according to this method.

The additional core for the block pattern may be made in one or two boxes, but it is suggested that two smaller cores are better than one large core because of the awkwardness of handling the large core, and we shall only consider the small core here. It is as well though not essential to miter the cores. Fig. 20 and 21 and 22 are three views of a corebox for the vertical post core. Fig. 20 is a longitudinal section and Fig. 22 a cross section. A bottom is necessary and the sides are planed to the correct taper. On the bottom a convex piece is screwed and the ribs and extra thickness pieces also fitted, but before the ribs or thickness pieces are fixed, pieces should be screwed to the sides, as while the box sides are parallel the core is of course tapered in the length.

It will be found necessary for the molder or coremaker to dismantle the box but the pieces that are screwed on the bottom are not removed. The ribs should be screwed from the sides of the box so that the molder can reach them conveniently. The corebox for the adjoining core is made in so similar a way that it is not necessary to explain it. Of course there is no convex piece on the bottom, the sides of the box would be parallel, and it would not be necessary to fit taper pieces inside against the sides as the box itself could be tapered by making the ends of different widths.

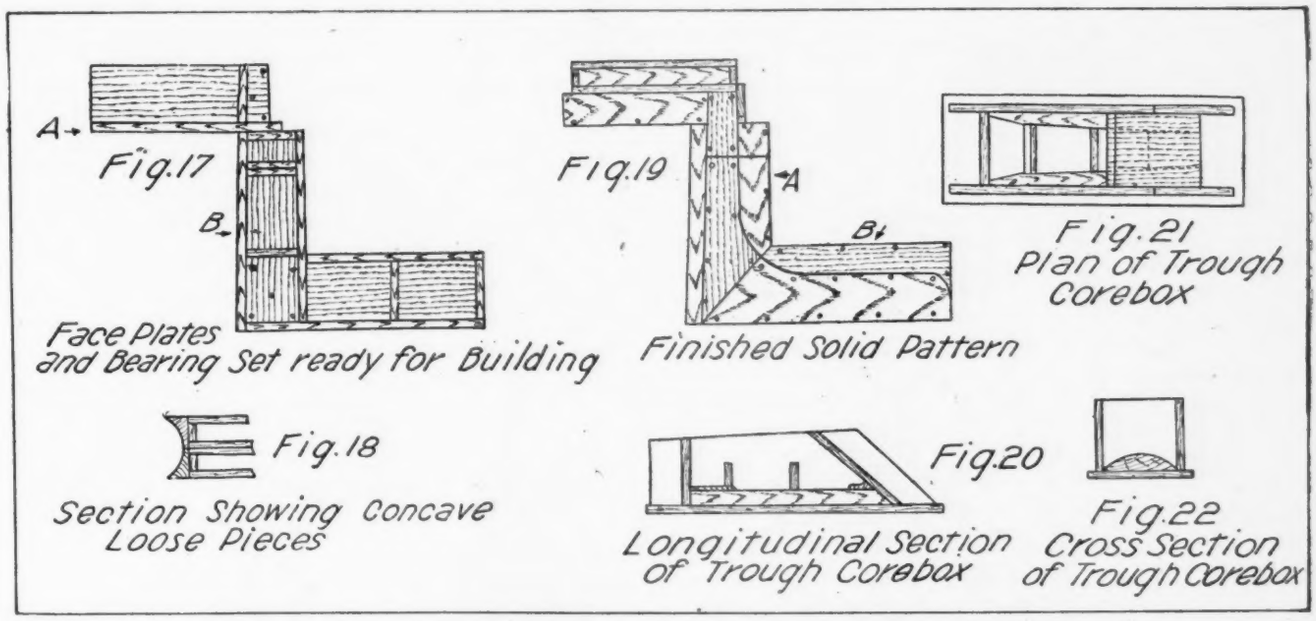


FIG. 17—FACE PLATES AND BEARINGS SET, READY FOR BUILDING FIG. 18—SECTION SHOWING CONCAVE COREBOX LOOSE PIECE FIG. 19—FINISHED SOLID PATTERN FOR STERN FRAME FIG. 20—SECTION OF TROUGH COREBOX FIG. 21—PLAN OF TROUGH COREBOX FIG. 22—CROSS SECTION OF TROUGH COREBOX

Makes Rapid Recovery

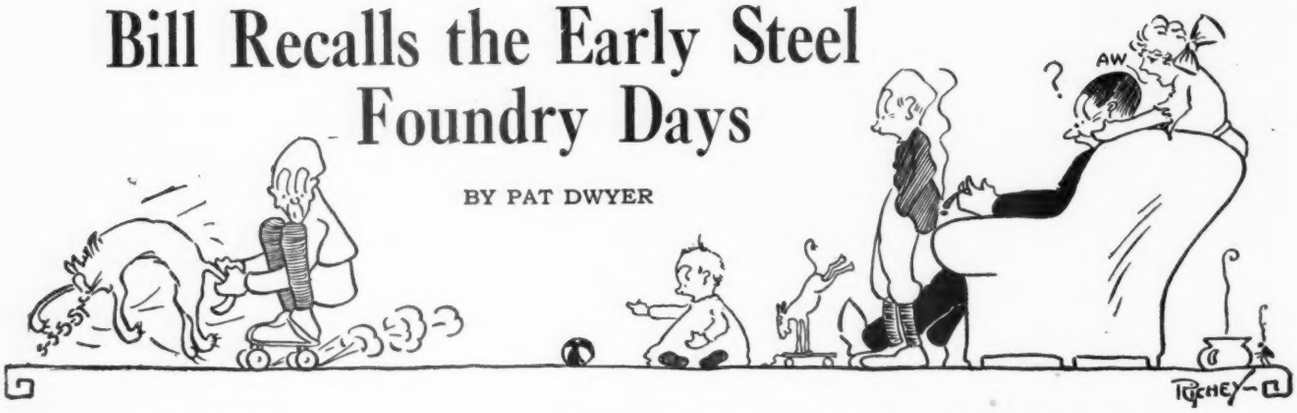
The Tabor Mfg. Co., Philadelphia, suffered a severe fire on Oct. 30 which damaged its old plant to such an extent that operations will not again be carried on in the buildings affected. The damage to equipment and stock was large but not serious and the loss was covered by insurance. The company at once arranged to carry on its work in the shops of a number of other manufacturers in Philadelphia under supervision of workmen from the Tabor plant. Deliveries of molding machines made since the fire have already been effected, and will continue with only slight interruption. The company had a new plant under construction which is being occupied as rapidly as possible and it is expected that this new plant will be in full operation by Dec. 10. The patterns and drawings were not in the portion of the old plant which was destroyed and for this reason the return to normal operation has been greatly expedited.

The Bonnot Co., Canton, O., will install pulverized coal systems at the Marion Malleable Iron Works, Marion, Ind., the Grand Rapids Malleable Iron Works, Grand Rapids, Mich. and the Franklin Steel Works, Franklin, Pa.

T. A. Willison & Co., Inc., Reading, Pa., manufacturer of safety goggles, recently has established a New York office at the Bush Terminal Sales building, under management of William Wortman.

Bill Recalls the Early Steel Foundry Days

BY PAT DWYER



ONE night recently I was sitting back in an old rocking chair enjoying a quiet smoke after the strenuous efforts of the day, and at the same time dispensing words of wisdom on homework problems to several young people who think that "Paw" knows everything. I have derived a great deal of pleasure from this mild form of exercise for many years. I kept up with the older ones as long as I could, and then advised magnanimously that they would derive more benefit from their studies if they worked out the problems for themselves while I devoted my time to the little ones who were courageously struggling through the forest of decimals and fractions for the first time. We had almost finished the list of exercises for the night when Bill arrived and joined our circle. "Hello," said he, "I see you have turned school master or are you doing this as a side line?"

I told him that while the exercise had always afforded me a certain amount of pleasure I had no intention in the world of adopting it as a profession. I said I did not mind teaching my own children, it was a labor of love; but if I attempted to teach other children and found them as dense and as thick as some of the Yahoos I had attempted to teach in the foundry I was afraid I would be tempted to use a club and would get myself arrested for cruelty to dumb animals.

"Education is all a matter of opinion," said he, "and it all depends on whether a pupil seeks knowledge voluntarily or whether it is slipped to him in carefully concealed tabloid form. There is another thing about education to which I should like to draw your attention. There are some things which can be learned from books and there are others which are only to be learned from actual experience. I worked in a place one time and an incident which happened there will illustrate what I mean.

"A new iron and steel plant was built in an out-of-the-way part of the world. In company with other gentlemen of fortune I found my way there and got a job in the foundry. It was some joint, believe me, for the first year or two; but as is often the case with humans, it has become a quiet and humdrum foundry during recent years. It has reached the stage where some of the molders are known as 'Home Guards' and some of their sons who were born after their parents reached the town have already finished serving their apprenticeship in the shops and mills of the company. But I'm off my subject.

BILL LEARNS ABOUT AMATEUR TEACHING

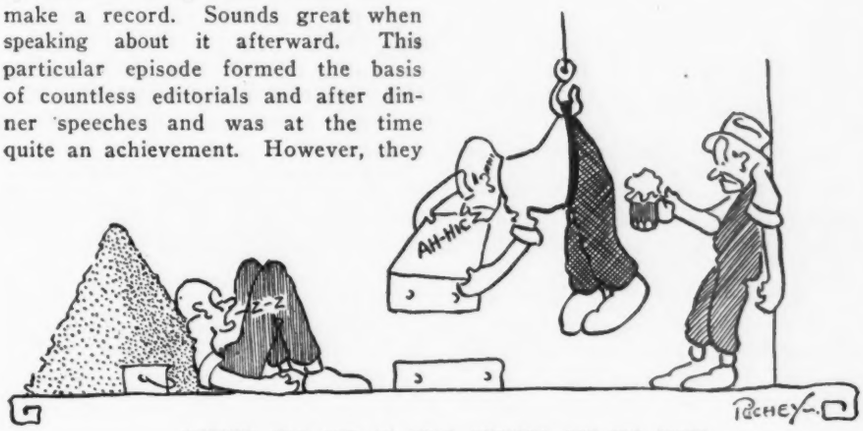
"When I look back it makes me realize I am growing old. As everyone knows, there are only two classes of people who wander away from a direct statement, that is those who are old and those who are feeble-minded. Now of course I object strongly to being classed with the latter so the only alternative left me is to admit that I have seen quite a few years approach, go by and disappear. In the good old days, that is the days which I spent flitting from place to place, the days during which the events I am telling you about occurred, the years approached at a snail's pace and crept by on leaden feet; but latterly they approach on flying wings, whirl through their allotted 12 months before I fairly realize that they are present and they have vanished in the shades of oblivion before I become accustomed to writing the correct date on a letter.

"Do you remember a song about 'Rolling down to Rio with a Drunken Dago crew? I wish the lad who wrote that song could have worked a while in this foundry I am talking about. Most of the men who came in sober in the morning would be pickled before noon and those who showed up in the afternoon would be practically useless. I have seen them so unsteady on their feet that their helpers had to help them to get up on a cope. The strange part of it is that they lost very few castings. There was one man I remember in particular. He came there from the Hecla in Brooklyn. He worked for over a year and was never what you would call perfectly sober during that time. However, what was more important in my mind, he never lost a single casting and this despite the fact that he was working at a piece work rate which netted him two days' pay each day.

"I see that I am getting off the track again but it all has a certain bearing on what follows, for to para-

phrase one of R. Kipling's pieces, 'I learned about molding from them.' They were good.

"The shops were running nearly a year before a heat was taken off either in the open-hearth or blast furnace departments. One of the open-hearth furnaces was rushed to completion and a heat taken off on Dec. 31. You know one of these spectacular things that men do to make a record. Sounds great when speaking about it afterward. This particular episode formed the basis of countless editorials and after dinner speeches and was at the time quite an achievement. However, they were making steel in several furnaces before the blooming mill was ready to receive it.



NOTHING WAS DRY IN THAT FOUNDRY BUT THE CORES

"About this time the master mechanic decided that he would have some steel castings made. A canvass of the foundry force was made to see if any of the men were familiar with steel foundry practice. It so happened that this man from the Hecla in Brooklyn and I were the only ones who had any experience in steel founding. As the older and more experienced man he was consulted first in regard to the matter. He objected strongly to giving up his piece work job to do experimental work on a day work basis. The proposition was then put up to me and I embraced it eagerly. The difference between us was that he was dry and needed the money and I was young and needed change and experience. The job seemed to promise a certain amount of variety and interest and the promise was redeemed with interest. I had some queer experiences down there.

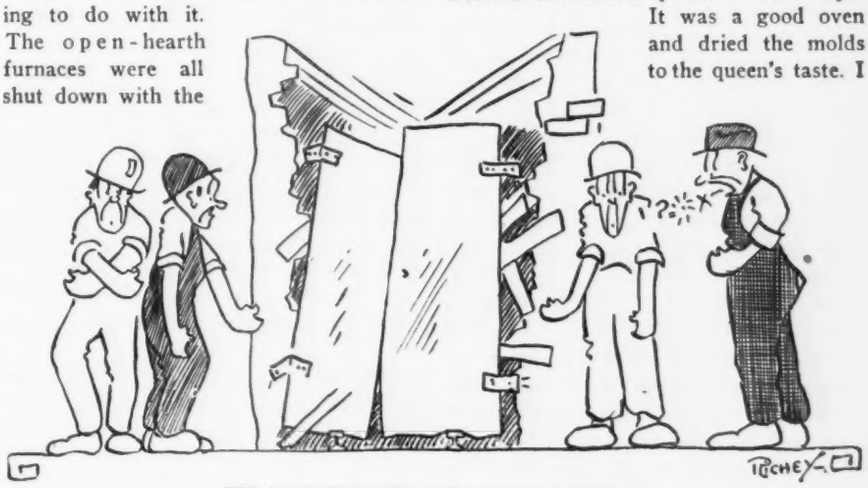
"In the course of time other men were sent down with me and we had quite a little foundry. Then one of those periodical panics came along, all the money went into hiding, the sun ceased to shine and everything turned blue. The company shut down the greater part of the plant, laid off half the men and in order to make a complete job of it and call it a day before knocking off they reduced the wages of those who remained. The same condition prevailed all over the country so I took my little trimmed envelope and stayed on.

"Up to that time we had been drying our molds by covering them over with sheets of corrugated iron and letting a gas flame play over the face. The supply of gas became limited when the greater number of the coke ovens were allowed to cool off and it became necessary to dry nearly all the work with wood fires.

"In the general catastrophe, the master mechanic resigned and the assistant remained in charge. Whatever faults he may have had I must say that he was a real lady and never hurt any person's feelings. I daresay that he knew all the vagaries of pure science. If it were not pure I feel sure that he would have nothing to do with it. The open-hearth furnaces were all shut down with the exception of three and this savant decided that he would equip one of the idle furnaces as an oven in which to dry the molds. The foundry foreman, who had been inveigled into coming there from Chicago advised me one day of the proposed change and magnanimously condescended to ask me what I thought of it. I told him that the roof would fall in about a week. If the temperature could be raised and held constant the roof would last for some time, but to raise the temperature during the night and let the oven cool off during the day was a practice that would certainly bring it down. I don't think he placed much credence in what I said; or perhaps, as he was comparatively new on the job he did not like to offer any criticism or appear to throw any obstacles in the path of the M. M.; or it may have been the first open-hearth furnace he ever saw and really did not know what would happen.

"I have my own opinion, but as he is still in the land of the living I do not care to state it and besides it does not really matter. The only pertinent fact in regard to the matter is that the work went ahead. A narrow gage track was built on piers on the furnace hearth. The wall was knocked out of the north end of the furnace and a sufficient length of the track left protruding so that the crane could land a carload of molds upon it. A sheet iron door was rigged on one of the end buck stays so that the opening could be closed when the car had been pushed in the oven.

"A length of 4-inch gas pipe liberally supplied with ¼-inch holes for burners was laid on the furnace hearth to supply the heat. The three charging doors and the ports at the south end were bricked up. Everything worked satisfactorily for a few days. It was a good oven and dried the molds to the queen's taste. I don't remember exactly how many times we used it for, as I said before all these things happened a good many years ago, and anyway what's a few days among friends?



THE MESS WAS LIKE THE RUINS OF POMPEII

"We came to work one morning and upon opening the oven door we found a mess like the ruins of Pompeii and Herculaneum. A section of the roof, about 10 feet square, had

fallen during the night and made a total wreck of a carload of molds. I phoned the foundry foreman to come down and see the remains and advised my own sturdy henchmen to touch nothing until the coroner arrived. I will say this for them that they appeared quite willing to wait as long as necessary. In fact one of them was rude enough to remark that he hoped the gaffer would break his leg in his hurry. No such untoward accident occurred, however, which bears out St. James' statement that 'The prayers of the righteous prevaileth.' I often think that if molders' prayers were to receive the slightest consideration there would be an awful flock of cripples limping around.

"The innocent cause of these remarks appeared after an interval. He took one look in the oven and then gave an interesting exhibition of grand and lofty swearing in that grandest of all profane languages, the Scandinavian tongue. In justice to him I admit that he interjected and interlarded enough expressions taken from our milder if more picturesque American vocabulary to enable us to follow him with pleasure and appreciation.

"I don't know what report he forwarded to headquarters but I know that the oven was not repaired. Arrangements were made to furnish us with gas and we continued to dry molds in the old way until times got better and a regular oven was built. It is many years since I left there but through the medium of the molder's underground telegraph I understand that the gang was moved back to the iron foundry. They make and dry the steel molds there and ship them down to the open hearth on flat cars and have them poured. Then they are hauled back to the iron foundry, shaken out and the castings cleaned."

Artificial Crowds Natural Graphite

BY HENRY G. FERGUSON

GRAPHITE occurs in nature in two forms, crystalline and amorphous, and each form has its own peculiar uses. The term crystalline or flake graphite is commonly understood to mean graphite in crystals large enough to be visible to the naked eye; much of the graphite called amorphous in the trade shows a crystalline structure under the microscope. Crystalline graphite occurs either in veins as in the Ceylon deposits, or as flakes disseminated through rock, as in most of the deposits of crystalline graphite in the United States.

Artificial graphite may be used for any purpose to which natural graphite is put, except in the manufacture of large crucibles. Recently, however, patents have been granted for methods of manufacturing crucibles in which artificial graphite may be employed. Under one method a mixture of either natural or artificial graphite, fused bauxite (aloxite alundum), and clay is used. The second method is similar except that zirconia is used instead of fused bauxite.

Besides the graphite products in which artificial graphite enters into competition with natural graphite, there are a large number for which artificial graphite is particularly adapted. Chief among these are graphite electrodes, the demand for which has increased greatly during recent years.

Artificial graphite is manufactured chiefly by the Acheson Graphite Co., which utilizes electric power generated at Niagara Falls. The output has increased greatly in recent years from approximately 5,000,000 pounds in 1915 to 10,000,000 in 1918, and now forms an important element in the country's supply of graphite. The bulk graphite is made from either anthracite or from petroleum coke and is utilized mainly in lubricants, but also for paints, foundry facings, boiler scale preventatives and battery fillers. A high degree of purity is claimed for the lubricating graphite manufactured in this manner.

Some work has been done recently on the commercial recovery of graphite from kish. G. D. Dub, of the bureau of mines, recently visited a mill where kish graphite was being concentrated and the following notes are quoted from his report: "The product known as kish is a mixture of graphite, slag, iron oxide, fragments of iron and other materials that accumulate around a pig casting ladle or a bessemer or open hearth furnace. The graphite is formed during cooling by the crystallization of the excess carbon from molten pig iron. The kish obtained from refining has contained from 8 to 10 per cent of graphite carbon in the form of light, thin and fluffy flake. The method of concentrating and refining kish is similar in many ways to the methods employed with natural graphite. The chief points of difference are that kish is not subjected to crushing, but is carefully screened and treated with magnetic separators. Kish, as a possible source of graphite, should not be overlooked. At the present time, however, it is questionable whether enough of this material can be obtained to compete or interfere seriously with the mining of natural flake graphite."

Samples of the finished graphite received by the geological survey show a very clean, though light thin flake, which should be excellent for lubrication. A small quantity of high grade graphite has been recovered from old crucibles by Harry Schmehl, Chester Springs, Pa. The crucibles are crushed in a small mill and the graphite is recovered by oil flotation. Old graphite crucibles are also crushed and used in the manufacture of foundry facings but without separating the graphite from the matrix.

Ceylon graphite of the better grades is more largely used by crucible makers than domestic flake graphite and commands a higher price. During the war the tremendous increase in the manufacture of crucibles caused a demand for the Ceylon product much in excess of the available supply, and the price increased greatly over prewar figures. The following list gives the estimated percentages, by quantity, of natural graphite being consumed in this country for different purposes.

	Per cent
Crucibles	45
Foundry facings	25
Lubricants	10
Pencils and paints	5
Stove polish	5–10
All other uses	10– 5
	100

As compared with a similar table published some years ago, these figures show a relative increase in the graphite used in foundry facings and a relative decrease in the graphite used for crucibles and stove polish. If artificial graphite were included, the percentages would be less for crucibles and greater for lubricants. If value rather than quantity is considered, about 70 per cent of the consumption should be credited to crucibles.

Graphite for making crucibles should be of the crystalline variety and should have a high degree of purity. Most makers of crucibles prefer to use

Abstracted from report by Henry G. Ferguson of the United States geological survey, forming part 2 of the "Mineral Resources of the United States."

Ceylon graphite either alone or mixed with varying proportions of American flake, usually not exceeding 25 per cent of the mixture. The reason for this preference is in part because the the more nearly cubical fragments of Ceylon graphite have a much smaller surface area in proportion to their volume than the thin flakes of domestic graphite and hence require proportionately less clay as a binder. Ceylon graphite is said to be more nearly free from undesirable impurities, such as mica and pyrite. It is possible, however, to use domestic flake graphite alone in crucible manufacture with good success.

Specifications for crucible graphite vary widely. The standard for purity ranges from 85 to 90 per cent graphitic carbon, and the lower limit of size from No. 12 silk bolting cloth (125 mesh) to No. 8 (86 mesh). It has been found in practice that although flake carrying 85 per cent of graphitic carbon can be readily produced, the cost of a product containing 90 per cent is greatly increased. This is owing to the fact that small quantities of quartz, mica and other impurities are interbedded in the graphite flakes themselves, and the flakes must be broken to remove them. A sample of Ceylon graphite prepared for crucible use contained 85.06 per cent of graphitic carbon. In purity, therefore, the American graphite compares favorably with that from Ceylon. The question of the relative value of American and Ceylon graphite for use in crucibles is now being investigated by the bureau of mines.

The graphite consumed for making crucibles in this country during 1916 and 1917 amounted to about 24,000 tons each year. It is probable that more than 90 per cent was of foreign origin. During 1918 the graphite consumed for crucibles was probably not more than 20,000 tons.

This decrease was due, in part, to the increased use of electric steel furnaces and open-flame brass furnaces, and in part also to the fact that a better quality of crucible was made. It is probable that the further demand for crucibles will diminish rather than increase. The following table shows the rapid increase in the manufacture of electric furnace steel while the production of crucible steel has remained practically stationary:

	Crucible	Electric
1908	63,631	.....
1909	107,355	13,762
1910	122,303	52,141
1911	97,653	29,105
1912	121,517	18,309
1913	121,226	30,180
1914	89,869	24,009
1915	113,782	69,412
1916	129,692	168,918
1917	126,716	304,543

It is believed that with a return to normal conditions this difference will be accentuated. Recent developments in the electric furnace as applied to nonferrous alloys also give promise of a decrease in the use of crucibles. A rocking electric furnace designed in the bureau of mines showed costs of operation about one-half that of the coke-fired crucible furnaces used in the same plant.

The armistice found manufacturers and users of crucibles with large stocks on hand and because of the decrease in use that necessarily followed it will be some time before these are absorbed.

Next to crucibles, foundry facings consume the most graphite. In their manufacture, graphite is commonly mixed with talc or other substances. They are made from amorphous graphite, and the dust which is a by-product in the refining of flake graphite. Old graphite crucibles are crushed and used for the same purpose, as usually a high degree of purity is not required. A rough estimate of the graphite used in the country for this purpose places the quantity at 10,000 tons a year.

Boiler Castings Must be Steam Tight

By H. E. Diller

Question—We would like to know the best composition for iron to be used in house furnace castings. The metal in these castings must be dense enough to prevent leakage under steam pressure.

Answer—For different parts of the furnace, iron of different compositions must be used. We take it, however, from your letter, that you refer to the cast-iron parts of the boiler which must withstand the steam pressure. For these castings we would recommend iron with silicon between 1.75 and 2.25 per cent, depending upon the thickness of your castings. Manganese should run between 0.60 and 0.80 per cent. The sulphur should be kept low and not exceed 0.10 per cent. For these castings a low-phosphorus iron would be advantageous. By charging malleable-bessemer pig iron with scrap from this mixture, an iron below 0.20 per cent phosphorus can be obtained which would answer your requirements quite well.

Not only is it important for you to have the correct composition of metal, but it is also necessary that the iron be properly melted to avoid over oxidation and slag inclusions. We would recommend that you pay particular attention to the coke; see that a strong, low sulphur coke is used, that enough is put on the bed and between the charges and that, on the other hand, too much coke is not used. The correct amount will depend upon the quality of the coke and upon your local melting conditions such as the style and size of cupola, the amount of air pressure used, etc. It can be best determined by a study of the action of the cupola under your operating conditions.

The proper fluxing of the cupola is also important. We would recommend that you add on each charge 30 pounds of limestone and 2 pounds of fluor spar per ton of metal. Should you notice when using the fluor spar, that a larger amount of silicon than normal is burned out of the metal, or that the slag sticks around the tuyeres when the bottom is dropped, the amount of fluor spar being used should be cut down somewhat. You might also gain some advantage by adding 3 to 6 pounds of 80 per cent pea-sized ferromanganese to a ton of metal in the ladle. This would only help in case the sulphur is high or the iron has become oxidized in the cupola.

Offers Aluminum Data

"Side Lights on Aluminum and Nonferrous Metals" is the title of a comprehensive booklet recently published by the United Smelting & Aluminum Co., Inc., New Haven, Conn. Besides describing the company's products this publication offers general information on the metal mentioned. Among the subjects treated are: How to solder aluminum; how to cast aluminum; the general uses of aluminum; a description of various alloys and their uses; a description of the manufacture of sheet aluminum; and an explanation of tempers, grades and forms of rolled metal. A portion of the book is devoted to useful tables showing the specific gravities and weights of nonferrous metals; comparative hardness of metals; comparison of properties of aluminum and copper; physical properties of metals; wire and sheet metal gages; brands of copper in the United States; American and foreign standard specifications for pig lead and tin; approximate melting point of various metals; useful formulas in brass foundry practice; and general tables.

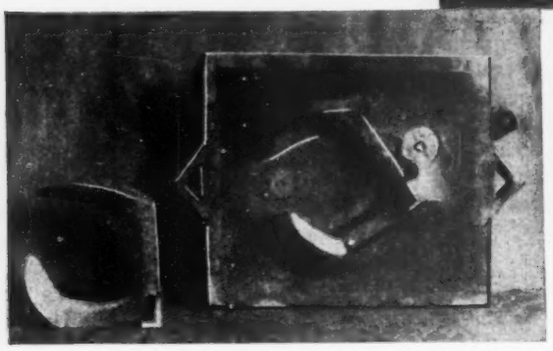
The Madison Pattern & Flask Works, Cleveland, recently has moved into a new plant at 10108 Detroit avenue, where additional melting facilities have been installed for handling nonferrous metals. J. F. Hines is president of the company.

The Maytag Co., Newton, Iowa, maker of washing machines, is erecting a large up-to-date foundry. G. W. Smith is works manager.

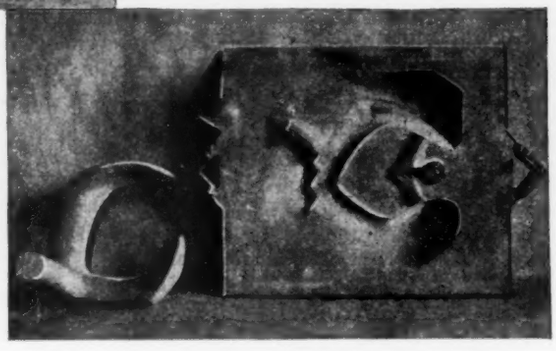
Practical Tips for the Foundryman

Making an Improved Match Plate for a Cobblers Last—Advantages of Straight Drag Prints—Pattern Making Students Make a Metal Core Box

SOMETIME ago the Canada Foundry & Forging Co., Ltd., Brockville, Ont., experienced some difficulty in producing a satisfactory match plate pattern for a 3-way cobbler last. The trouble was caused by shrinkage on the edge of the pattern underneath the plate. It was necessary to fill out the shrinkage with wax, and to renew the wax constantly. After numerous attempts to overcome the trouble, it was decided to determine the effect of making the plate and pattern separately. An ordinary match plate mold was put up, but the cope and drag were rammed harder than in usual practice. The cope was lifted off and laid on its back and the pattern removed. The drag was shaken out and rammed anew on the impression left in the cope. This mold then was rolled over, the cope lifted off and the match plate frame placed in position, after which the mold was closed and poured. The pattern for the last was made separately in another flask, and after being filed was fitted into the impression in the under side of the plate, and attached firmly by three screws. By this method of making the pattern and pattern plate separately, the shrinkage which always occurred when they were produced in one piece was avoided entirely. Consequently, the nuisance of having to fill out the pattern with wax was eliminated.



AT THE LEFT IS THE COPE SIDE OF THE PLATE WHILE THE DRAG SIDE WITH THE PATTERN READY TO BE ATTACHED IS AT THE RIGHT — ABOVE IS THE COMPLETED MATCH WITH PATTERN ATTACHED



By Fred Washburn

Advantages of Straight Drag Core Prints

BY H. N. TUTTLE

IN THE Nov. 1 issue of THE FOUNDRY there appeared a question on the subject of using straight drag prints in gated patterns. The chief advantage, in the writer's opinion lies in the greater ease of making the cores. A core cannot be rammed as easily through a small hole caused by a tapered core print as through a hole the full size of the core. This is especially true of multiple or gang coreboxes rammed by hand jarring on an iron plate.

When setting the cores on end on the dryer plate it is easier to balance them on the full sized end than upon tapered prints. For the same reason it is easier to carry the plates without having a spill.

Another advantage lies in the reduction of the number of coreboxes required, due to the straight print's adaptability to length. For instance, if in making a new pattern it is found there is on hand a corebox of the right diameter and of such length that the drag core print would be anywhere from 5/8-inch to 1¼ inches long, the corebox may be used for the new pattern, by making the drag print on the pattern the proper length to fit the core.

In a shop using many gated patterns, a number of coreboxes may be eliminated, saving the first cost as well as the storage space of the cores which are similar except in length. The number of the corebox to be used may be stamped on the drag core print of the pattern, so the molder has no trouble in getting his cores.

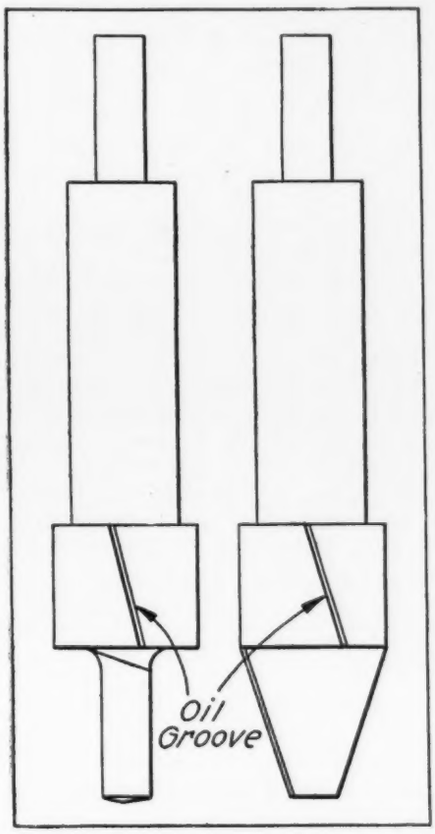
A system for numbering this type of corebox appeared in THE FOUNDRY several years ago. The first two digits referred to the number of sixteenths of an inch in the core diameter, while the other two indicated the number of quarter inches in length. Thus a corebox 13-inch in diameter and 3¾ inches long would be stamped No. 1315.

The custom we have followed is to make the middle diameter of the drag print equal to the diameter of the core, while the draft allowed makes the print one hundredth of an inch smaller at the outer end and the same amount larger at the pattern end of the print. This has been found to give sufficient draft to cause no trouble in tearing up, and of proper size to give the right pinch to the core.

About 300 per cent is saved in the first cost of making coreboxes whenever a multiple machined box is made. The straight print corebox may be reamed from the solid two-piece corebox stock with an ordinary flat faced reamer, whereas with the corebox having tapered ends, each corebox half must be made in three pieces, properly

machined and afterward screwed together. There is the alternative of milling it out of the solid with an expensive cutter and by an expensive process. The built-up box, also is much more likely to break as it is weakened by the style of construction.

The illustration accompanying shows two styles of an easily made reamer for drilling straight drag core prints. On the first roughing cut, made with twist drills a piece of cardboard is placed between the two halves of the stock. This causes the drills to cut equally in each half box. The cardboard is removed before the reamers are used.



REAMER FOR STRAIGHT DRAG CORE PRINTS

Pattern Making Students Make Metal Corebox

By B. Rupert Hall

Our wooden core boxes for the gas-engine cylinder were about to be replaced by new boxes of the same material. I was anxious to demonstrate to my class an inexpensive method of producing a metal core box. I selected this as a practical example and submitted the problem to the pattern planning department to test the ability of the students in devising a plan by which this work could be carried out.

Our first step was to ram up two half cores from the discarded core boxes and bake them in the usual manner. We took special care to allow for any discrepancies in form and our core mixture was selected keeping in mind the matter of metal shrinkage.

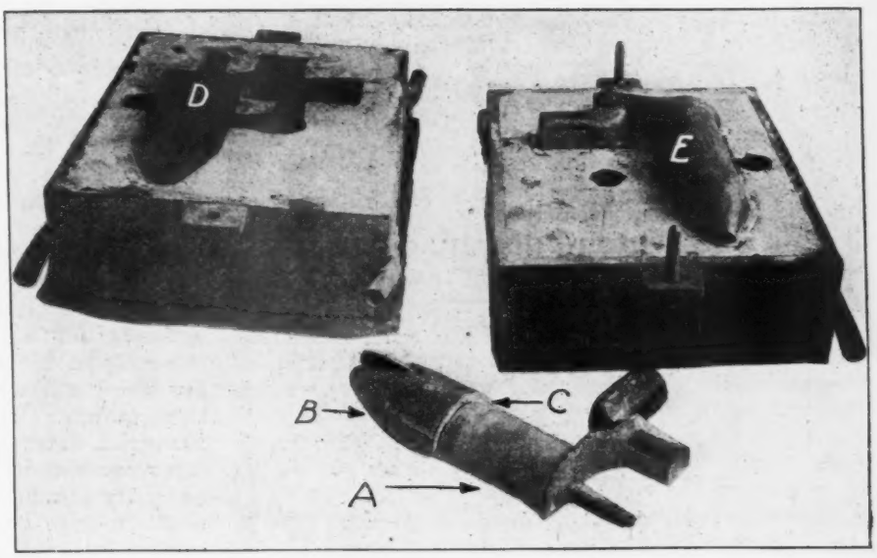


FIG. 1—DRAG, COPE AND PATTERN FOR METAL COREBOX

Having well formed cores we proceeded to produce the required patterns. This was done by first placing our cores on true core plates. We next obtained some clay, moistened it to the proper consistency, and rolled or swept it to the required thickness. This was done by taking two strips of wood, equal to the required thickness of metal in the core boxes, in this instance ¼-inch, and placing them on a flat surface. The moistened clay was placed between the strips and a roller or sweep used to reduce it to desired thickness. The thin sheet of clay was cut into suitable pieces and placed on the core as shown in Fig. 1, *A*. A portion of the core with the clay applied is shown at *B*. The portion of clay at *C* represents the metal thickness of corebox. Having covered the entire core with clay the surface was slicked off smooth making necessary allowance for draft. The core *A* and clay covering *D* were placed in the core oven and baked after which they were ready for the process of molding. The core and clay covering were placed on a follow board and the drag portion of flask placed in position and rammed in the usual manner. A bottom board was placed and clamped and the whole rolled over. The clamps were removed and the follow board taken off. The cope portion of flask was placed, rammed, and lifted and the core which served as a support to the clay pattern shell was removed leaving the mold as shown at *D*. To hold the core *E* in the cope, anchor wires were used, passing through the cope sand and secured in a suitable manner on top of the flask. The corebox castings thus produced are shown in Feg. 2.

The Doehler Die Casting Co., which has its main office and eastern plant at Brooklyn, and a branch plant at Toledo, O., has purchased a seven-acre tract in Chicago on which a new concrete structure will be erected. The company manufactures die castings in white metal, aluminum and brass alloys, bronze and aluminum backed babbitt lined bearings. The new building of the company in Chicago will be completed about Jan. 1.

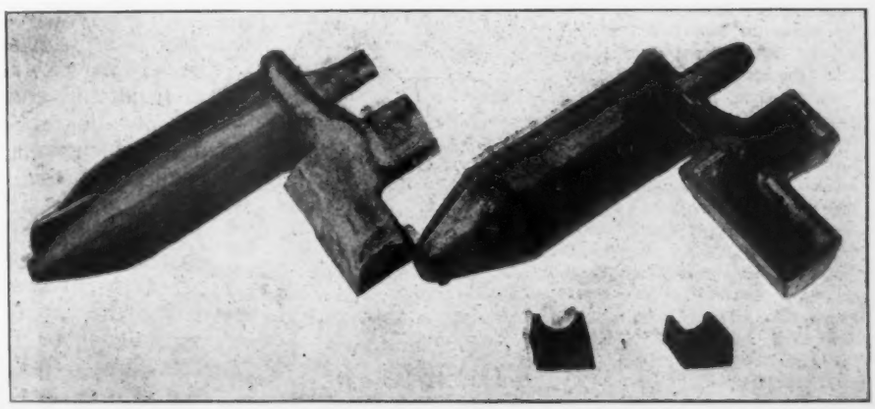


FIG. 2—THE FINISHED COREBOX CASTINGS

THE FOUNDRY

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Mechanical Equipment Paramount

THE foundry industry to a great extent is passing through a period of evolution. Mechanical appliances are taking the place of manual labor in a greater degree than was ever thought possible and to a greater degree than many foundrymen seem aware at the present time. The majority of foundrymen are conservative and hesitate to try out new ideas. Conservatism in adopting ideas or practices that are only in the experimental stage is commendable, but it is common knowledge that labor saving equipment has long passed the experimental stage and is proving its worth wherever it is installed and operated intelligently. The huge output credited to some foundries never could have been attained if manual labor were the only agency available. Even if an adequate number of men could be had it would be impossible to co-ordinate their efforts and get the results of which mechanical means are capable. It is not possible to get sufficient men to meet the large and steadily growing demand for castings, and the labor scarcity is increasing rather than diminishing. Heretofore the mechanical methods of production have not taken as prominent a part in the foundry as in other lines of industrial achievement, but the trend of advanced foundry practice is unerringly toward the substitution of mechanical aids for human labor. While it seems probable that manual labor will always play an important part in many phases of the castings industry before another decade has passed the foundry will be on a par with allied industries in the employment of mechanical means to increase production.

A Metallurgical Paradox

OXYGEN is beneficial to iron. Oxygen is detrimental to iron. These theories are directly opposed, yet both statements have their advocates who state that they can prove their contentions. This is probably due to the state in which which the oxygen exists in the iron under different conditions of melting. However, in this direction we are working in the dark for no means have been found for determining the condition of oxygen in cast iron. Cast iron contains large amounts of silicon and carbon, both of which readily combine with oxygen to form a constituent of slag in the one case and a gas in the other. Both of these oxides tend to come out of the iron and some metallurgists question whether iron oxides ever exist in cast iron. One theory holds that oxygen is absorbed by the iron in the cupola and later is evolved as the metal solidifies. In steel containing oxides of iron, these oxides can be detected indisputably under the microscope, but with cast iron no metallographist has detailed any method by which oxide inclusions may be shown. Some metallurgists claim that the increased strength of semisteel compared to cast iron is due to the steel becoming oxidized, while being melted. They hold that the oxygen absorbed in this way is the cause of the increased strength of semisteel. This increase of strength cannot be explained by chemical analyses. Cannot the microscope be made of more service to the foundry metallurgist? Surely if the metallurgical paradox which has been outlined could be solved with the aid of the microscope a great advance would follow in the founding of cast iron.

Trade Outlook in the Foundry Industry

ALTHOUGH confronted by advancing prices, uncertain deliveries of raw materials and constantly increasing scarcity of labor, casting manufacturers are flooded with an avalanche of business. This heavy demand for castings is not limited to a few sections of the country nor to a few definite lines of manufacture. Starting in the Middle West and fostered by tremendous production in the automotive industries, the demand has gathered momentum until within the past month a tremendous tonnage from every conceivable source has smothered the Mississippi valley foundries and spread into the East and South, seeking available plant capacity whether near or remote.

Gray Iron Leads

Jobbing and specialty shops are crowded to capacity. Gray iron castings are in the heaviest demand and in proportion to their preponderance of tonnage. Stove, radiator and sanitary ware makers cannot hope to fill contracts on their books before next summer. Cast iron pipe, particularly for industrial uses, is in unprecedented demand. This demand, coupled with expected sales, probably will result in advancing prices. Machine tool builders, and makers of special machinery are seeking available foundry capacity in quarters hitherto unexplored. In many cases automobile manufacturers are building new foundries or constructing extensions to those they now have, as jobbing shops which previously have had ample capacity to supply their demands have orders which it will take until next spring to fill. The rubber industry with its pyramiding requirements fostered and intensified during the war has spread beyond all previous expectations, bringing a steadily accelerated demand for special machinery, roll and mold castings. The Akron district, though liberally supplied with foundries specializing in castings for the rubber trade, has been unable to meet the present abnormal requirements and orders for castings from this district have been placed with foundries in Pennsylvania, Delaware and New Jersey. The increased demand in the East has strengthened prices. Cast iron boilers and radiators have been advanced 7½ per cent, while supplies, such as valves and pipe fittings, have been increased from 5 to 25 per cent. Radiators were sold by foundries for about 17 cents per foot previous to the war. The price was advanced until at the time of the armistice the quotation was about 40 cents per foot, but this price fell quickly. However, continued building activity has induced a greater demand which in turn has resulted in strengthened prices until at the present time radiators are quoted at about 34 cents per foot. During the past few weeks southern foundries, particularly those in the vicinity of Birmingham, have received a number of inquiries for castings from South America and from Cuban sugar manufacturers. These orders are of sufficient volume to assure plenty of business for these foundries during the winter.

Prices of Raw Materials for Foundry Use

CORRECTED TO NOV. 25

Iron		Scrap	
No. 2 Foundry, Valley	$32.00	Heavy melting steel, Valley	$22.00 to 22.50
No. 2 Southern, Birmingham	30.00 to 31.00	Heavy melting steel, Pittsburgh	22.50 to 23.00
No. 2 Foundry, Chicago	32.00	Heavy melting steel, Chicago	20.50 to 21.00
No. 2 Foundry, Philadelphia	36.10	Stove plate, Chicago	27.00 to 27.50
Basic, Valley	30.00	No. 1 cast, Chicago	31.50 to 32.00
Malleable, Chicago	32.50	No. 1 cast, Philadelphia	28.00 to 29.00
Malleable, Buffalo	35.25	No. 1 cast, Birmingham	24.00 to 25.00
Coke		Car wheels, iron, Pittsburgh	29.00 to 30.00
Connellsville foundry coke	6.50 to 7.50	Car wheels, iron, Chicago	28.50 to 29.00
Wise county foundry coke	8.00 to 8.50	Railroad malleable, Chicago	27.50 to 28.00
		Agricultural malleable, Chicago	27.50 to 28.00

Malleable Active

Labor scarcity continues to be the only limiting factor in the production of malleable castings. The demand has increased steadily during the past few months, so that during the past month shipments from malleable plants reached 79 per cent. This growth in demand has been unaccompanied by even a small portion of ordinary railway buying, and many of the shops which in the past specialized in railway work have taken on automobile orders until now it is doubtful if railway inquiries would find sufficient foundry capacity available to meet even a normal need. Agricultural implement manufacturers are seeking to place orders six months in advance for malleable castings. Supplies of iron and fuel continue ample to meet the needs of malleable makers until after the first of the year. Steel foundries are more active, but still are far from their normal prewar activity. Although most foundries are supplied with sufficient iron to supply their needs until well into January, and coke has been available in most sections, the demand for both these commodities has increased steadily. Industrial uncertainties and the reluctance of pig iron producers to sell for 1920 delivery have combined to accentuate the demand for iron and have brought a steady increase in price. It is estimated that many furnaces already are oversold through the first quarter. Prices advanced by makers to cut off sales have not served to stem the tide and some furnaces have withdrawn from the market. Automobile manufacturers who operate their own foundries have been particularly insistent buyers, and sales to these interests in the Detroit district alone have totaled over 100,000 tons of foundry grades in two weeks.

Brass Shops Busy

Building activity continues to afford a strong demand for brass fittings of all classes, particularly electrical and plumbing goods. Aluminum again is coming into its own in the automobile field and the tendency toward lighter passenger cars promises to develop new uses for aluminum alloy castings. Copper prices are weaker due to a heavy surplus on hand. Prices of nonferrous metals, based on New York quotations, follow: Copper, 18.75c to 19.00c; lead, 6.90c; tin, 54.50c; antimony, 9.12½c to 9.25c; aluminum, No. 12 alloy, producers' price, 31.50c, and open market, 30.00c to 31.00c. Zinc is quoted at 7.75c to 7.85c, St. Louis.

Comings and Goings of Foundrymen

W. T. HAYS, who for the past four years has been general superintendent of the Dominion Steel Foundry Co., Hamilton, Ont., Canada, has been made works manager of the Adirondack Steel Foundries Corp., Watervliet, N. Y., an associated interest of the Dominion Steel Foundry Co. Mr. Hays was general superintendent of the Scullin Steel Co., St. Louis, before becoming associated with the Canadian company. The new plant of the Adirondack Steel Foundries Corp. is now under construction and it is planned to start operation with a 25-ton open-hearth and two 3-ton electric furnaces about April 1. C. W. Sherman is president of both the Hamilton and Watervliet interests.

Louis J. Schneider has been made general sales manager of the Clark Tructractor Co., Chicago.

Thomas S. Leger has been made foreman of the Stevens Foundry Co., Winooski, Vt.

J. Palmer Barstow has been elected president and treasurer of the reorganized Barstow Stove Co., Providence, R. I.

Charles J. Poduska formerly connected with a foundry in Waterloo, Ia., has been made foreman of the Wilcox & Stewart Foundry Co., Cedar Falls, Ia.

O. K. Carpenter, formerly with the Bayonne Steel Casting Co., Bayonne, N. J., now is superintendent of the Millbury Steel Foundry Co., Millbury, Mass.

W. S. Atwood, for many years assistant to the president, and A. D. Neal, purchasing agent of the Canadian Car & Foundry Co., Montreal, have been chosen vice presidents of the company

C. H. Hoefer has resigned as foundry superintendent of the Joyce-Cridland Co., Dayton, O., to accept a similar position with the Fluid Compressed Steel Co., Keokuk, Ia.

J. J. Newhart has resigned his position as superintendent of the T. L. Smith Co., Milwaukee, to become foundry superintendent of the Challenge Machinery Co., Grand Haven, Mich.

J. G. Hallas, has resigned as purchasing agent of the Duquesne Steel Foundry Co., Pittsburgh and Coraopolis, Pa. His successor is M. P. Emmerich.

Paul M. Lincoln, for many years commercial engineer of the Westinghouse Co., has resigned to become consulting engineer for the Lincoln Electric Co., Cleveland.

A. T. Willis has resigned his position in the malleable department of the General Electric Co., Erie, Pa., to become manager of the American Chain Co. malleable plant now under construction at York, Pa.

Arthur Phillips has resigned his position as metallurgist at the Bridgeport Brass Co., Bridgeport, Conn., to become assistant professor of metallurgy at Yale university, New Haven, Conn.

Daniel Boyd has accepted a position with the metallurgical department of Queen's university, Kingston, Ont., Canada. Mr. Boyd will have charge of special research on nonferrous alloys.

Charles B. Carter who served in France with the rank of captain and who has been connected with the Chicago Steel Foundry Co., Chicago, since his return from military service, has been made sales manager of that organization.

A. J. Snyder who has been foreman of the brass foundry of the Aluminum Castings Co., Detroit, has been promoted to the position of general foreman of the aluminum foundry of the same company in Detroit.

F. J. Ryan, president, American Metallurgical Corp., Philadelphia, addressed a recent meeting of the Philadelphia Foundrymen's association on the use of electricity in melting furnaces. He described the Charles A. Week's rotating furnace for brass melting, the Collins type nonferrous furnace and also some common types of steel melting mediums.

Philip E. Wright, for many years pig iron sales agent for the Thomas Iron Co. in the Philadelphia and New York territories, has terminated his connection, effective Dec. 31. Mr. Wright will retain his Philadelphia and New York offices and will sell Pennsylvania and Virginia irons. In addition, he will continue to sell foundry and furnace coke.

Conrad A. Lund who for three years past has been superintendent of the Harris-Hanson Foundry Co., Stamford, Conn., has resigned to establish a brass and aluminum foundry of his own in Springdale, Conn.

Russell W. Stovel who served in France as chief of the terminal facilities division of the army transport service with the rank of lieutenant-colonel has been appointed consulting engineer of Westinghouse, Church, Kerr & Co., Inc., New York. As a member of the firm, Mr. Stovel will devote his time to developing the company's mechanical and electrical work.

Sand Handling Problems Are Discussed

The subject of handling foundry sand attracted a large number of the members to the November meeting of the New England Foundrymen's association at the Exchange club in Boston. H. L. McKinnon, vice president of the C. O. Bartlett & Snow Co., Cleveland, read a paper describing the various types of sand handling equipment in use in foundries today and presented slides showing in detail the operation of many successful installations. Mr. McKinnon said that it is the nature of sand in a foundry to pack. Molding sand tends to buck every endeavor to shift it from one place to another or to change its form. Some of the greatest difficulties are met in connection with taking tempered sand from storage. Practically the only method of moving sand is to pick it up and take it to where it is needed, and dump it, and this principle is behind all successful handling equipment.

It was stated that the problem is an individual one for each foundry to solve and is essentially one of engineering. The questoin of economy is such a complicated one that no definite figures can be given. A capacity of 30 tons per day was offered as an approximate dividing point between a foundry too small for sand handling equipment and one in which such equipment is needed.

In the discussion after the paper was read, Mr. McKinnon said that the average depreciation and maintenance on sand handling equipment would not exceed 15 per cent a year. When asked about removing nails, rods, and other pieces of iron from the sand, Mr. McKinnon recommended the magnetic pulley. Another point brought out in the discussion was the fact that sand-conveyor belt speeds may often be so great as to cause small pellets or marble-like lumps to form in molding sand at the point where the

sand is removed from the belt. This condition is obviated by a flat belt with removing plows. Any speed below 75 feet per minute does not develop this trouble.

National Founders Hold Annual Convention

More than 300 members of the National Founder's association attended the annual convention of that body, held at the Hotel Astor, New York, Nov. 19 and 20. Addresses were delivered by President William H. Barr, William H. Van Dervoort, president of the Root & Van Dervoort Engineering Co., Moline, Ill., James A. Emery, Prof. J. Laurence Laughlin, economic advisor of the National Industrial Conference Board, Richard A. Waldo, manager of the Inter-Racial consul, George F. Monahan, general consul of the association, H. P. Bole, vice president Hydraulic Pressed Steel Co., Cleveland, and L. R. Clausen, Deere & Co., Moline, Ill.

At the closing session of the convention William H. Barr, Lumen Bearing Co., Buffalo, was re-elected president. J. Goslin, Jubert & Goslin, Machine & Foundry Co., Birmingham, Ala., was elected vice president. A. E. McClintock was re-elected commissioner and J. M. Taylor was re-elected secretary.

Safety and Shop Welfare Prove Live Topics

Pittsburgh foundrymen at the November monthly meeting were addressed by Eugene S. Willis of the Safety First Supply Co., Pittsburgh, and Col. Cameron C. Smith, chairman, Union Steel Casting Co., Pittsburgh, who during the war served as production manager of the New York district army ordnance office, and after the war was a member of the war claims board.

In Mr. Willis' talk on "Safety First as Applied to the Foundry," it was brought out that workmen generally are opposed to wearing goggles at first, but that shop and foundry officials by perseverance can make the men see the advantage of this means of protection to the eyes. Cooler and more comfortable leggings were thought desirable.

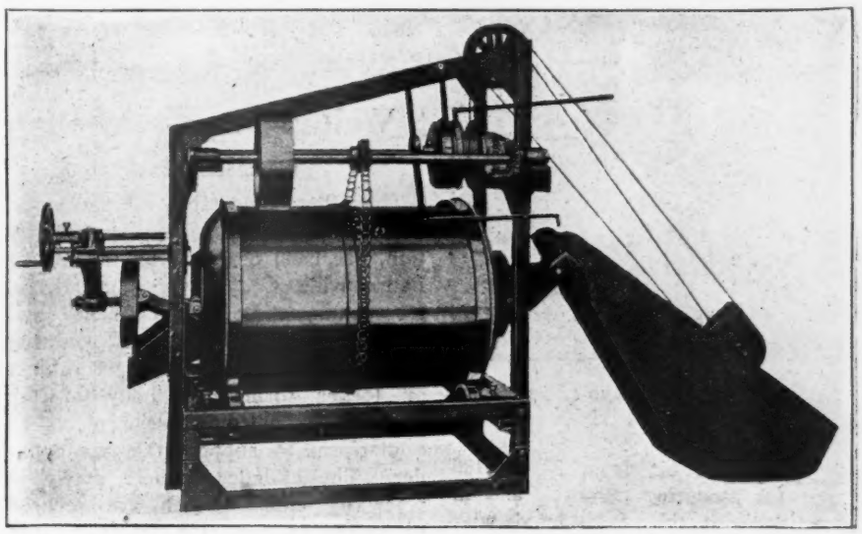
Making the shop an attractive place to work, by the introduction of recreation periods during the day, such as moving pictures during the noon hour was suggested by Colonel Smith who also recommended shop stores where employes might buy necessaries at cost and it was his experience that the employment of a trained nurse to look out not only for the welfare of the men but of their families was helpful.

Invents New Automatic Tumbling Barrel

A new type of tumbling barrel installation, manufactured by the Ideal Concrete Machinery Co., Cincinnati, loads automatically from the ground level and discharges the work directly into buckets or buggies without stopping the rotation of the barrel. To guard against over-tumbling or insufficient cleaning of the castings, the operator may reach into the barrel and remove a sample of the work for inspection at any time without stopping the machine.

During the tumbling operation the plug, shown in the accompanying illustration, is set in place closing the barrel. When in this position the hinged chute hangs straight down inside of the drum so as not to interfere with the tumbling. To discharge the cleaned castings, a hand wheel operates a screw which withdraws the plug and brings the chute up and into the discharge position. A worm of 1½-inch angle iron fastened to the inner surface of the barrel carries the castings to the chute when discharging.

Barrels are supplied with either a solid shell, a shell perforated to screen out sand or sawdust, or a shell equipped with axial slots to dispose of trimmings. The shell is made of ¾-inch steel plate rolled to size and butt welded, while the drum heads are ⅞-inch castings protected from wear by steel bands shrunk around the running track. Chilled iron rollers 12 inches in diameter support the drum. The loader skip is raised by power transmitted through a 14-inch contracting band hoist. An automatic stop prevents the loading skip from being hoisted too far. Where an exhaust barrel is desired, the exhaust is taken care of by the hollow trunnion in the discharge plug to which a flexible steel tube is attached.



TUMBLING BARREL WHICH IS EQUIPPED WITH POWER LOADING DEVICE

Plan Large Addition

Fairbanks, Morse & Co. soon will start the construction of a large addition to its gray iron foundries at the Eclipse works, Beloit, Wis., which will make this one of the largest casting plants in the Middle West. Official announcement of the plans has been made by W. S. Hovey, general manager at the Beloit establishment. The new foundry will be 550 x 900 feet, of brick and steel, and provide nearly 500,000 square feet of floor space. The capacity will be 400 tons a day, with an initial equipment of eight cupolas. The estimated cost is given as $1,500,000. About 1500 men will be added to the payroll to man the new plant and its auxiliaries, with an increase of 1000 to 1500 workmen in the machine and assembling shops to handle increased output thus made possible. The present plant employs between 3500 and 4000 men, normally. The large list of new equipment and machinery which will be required for the foundry includes about 70 electric cranes of various capacities. It is estimated that between 5000 and 6000 tons of structural steel and 175,000 square feet of metal sash for sidewalls and monitors will be required.

D'ooge and Furlong who represent J. W. Paxon Co., supplies and sand blast machinery; Link-Belt electric hoists, and Milwaukee electric cranes have moved their office from 826 Ford building to their warehouse, 1717 Michigan avenue, Chicago.

New Type High and Low Pressure Burners

The application of fuel oil to foundry uses is becoming so general that new burners and furnaces are of special interest. There are two classes of burners, the one operates under low pressure while the other requires a high pressure in the line. The Hauck Mfg. Co., Brooklyn, is introducing a new burner which is a combination, low and high pressure type. This is shown in Fig. 1. The company states that the burner operates

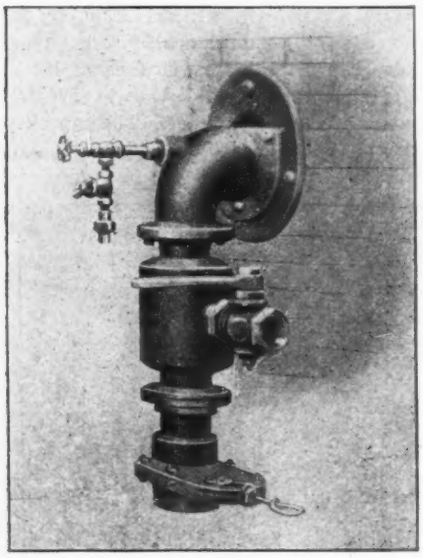


FIG. 1—COMBINATION HIGH AND LOW PRESSURE BURNER

with compressed air from 20 to 100 pounds for atomizing purposes, and in connection with this, it is used with fan blast to complete the combustion. The burner atomizes crude fuel, or kerosene oil, which is fed by gravity or pressure.

Because of the fan blast pressure, it is stated the flame is clear and neutral, hence it does not have a cutting or oxidizing effect on crucibles or metal. The burner is so designed that it may be equipped with an attachment to enable it to burn either natural or artificial gas, should this be found desirable for any reason. This type burner is recommended where a large volume of heat is required.

The Hauck company recently has also developed and installed in a number of places, a low-pressure burner which is said to have been found to work with success on core and annealing ovens, forging furnaces and in many other places where it may be undesirable to use high pressure air. The objectionable noise, where high pressure type burners are used, is practically eliminated in this new burner.

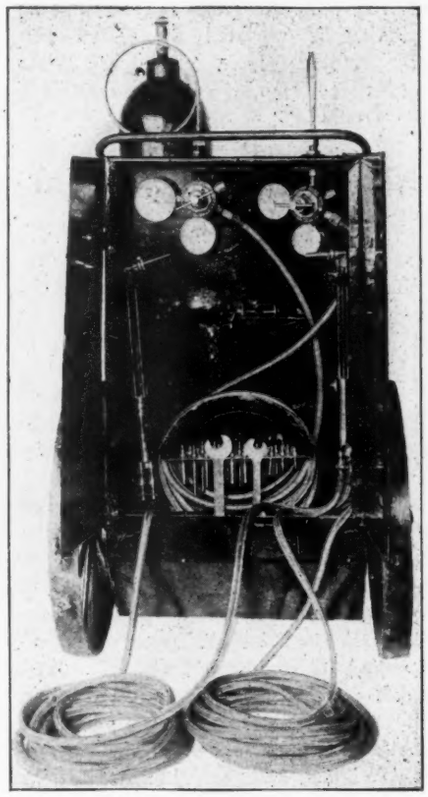
The burner, which is illustrated in Fig. 2, operates with fan blast pressure at 1½ ounces. It burns crude, fuel or refuse oil, which is fed either by gravity or by pressure. A special combustion chamber is supplied with the burner. The flame fully develops in this chamber and as it enters the furnace it is blue-red and has intense heat. The combustion box which is lined with fire brick, may be attached easily to any forge or furnace so that the opening of the chamber will be parallel or even with the opening of the furnace.

A fan and electric motor are unit with the burner. The motor is supplied with a socket for connecting with the lighting or power system. It may be operated on either a direct or alternating current.

A crucible furnace equipped with this low pressure burner has been designed by the Hauck company. This furnace is made of 3-inch special fire brick encased in a ruggedly constructed steel shell. The swing-top cover has a vent or exhaust hole.

Welding Outfit is Self-Contained

The all-steel portable cabinet truck, shown in the accompanying illustration, has been designed by the Davis-Bournonville Co., Jersey City, N. J., for transporting oxyacetylene and oxyhydrogen welding and cutting equipment. An upright steel cabinet or locker forms the body of the truck. The bottom base projects as a platform to support the gas cylinder. The cylinder is held firmly in place by chains which are secured to hooks in the side frame of the cabinet. The entire outfit is mounted on two wide-tired wheels of large



SELF-CONTAINED GAS WELDING EQUIPMENT

diameter with cast iron hubs, steel spokes and tires. The axle is a 1-inch round bar. The cylinder platform is strongly braced to the cabinet body by side straps which are extended to form a ¾-inch round handle. Two steel doors are swung on strap hinges securely riveted to the side walls of the cabinet. The doors lap when closed and a suitable hasp is provided for a padlock.

The cabinet is designed to hold all

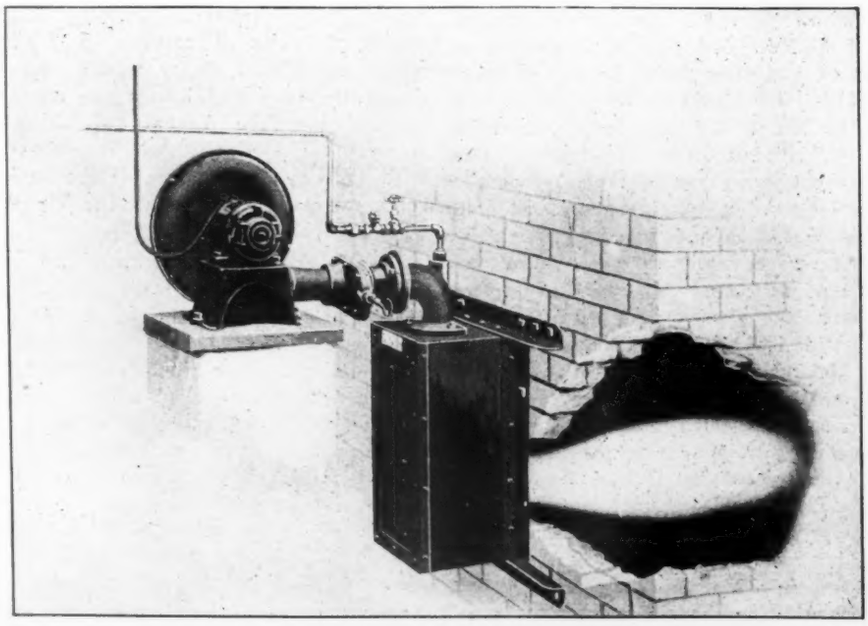
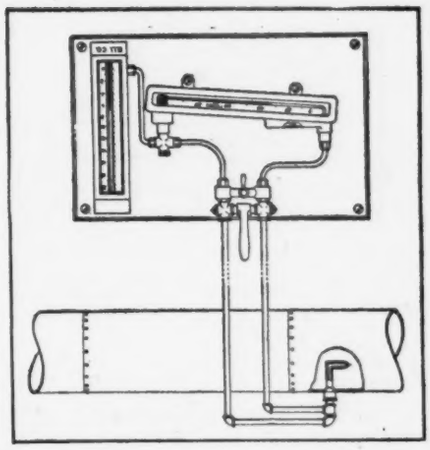


FIG. 2—LOW PRESSURE BURNER WITH COMBUSTION CHAMBER GIVES A NEUTRAL FLAME

the necessary accessories for cutting and welding operations. Two pressure regulators, each with high and low pressure gages are attached to the inside of the locker in a fixed position and thus are accessible to the operator. Connections between the regulators and the gas cylinders are made with seamless ¼-inch brass coils attached to the top of the locker and provided with nipples and nuts. When the equipment is not in use, the doors may be locked.

Gage Aids Cupola Control

Many cupolas are provided with blast pressure gages for determining the pressure under which blast is sent through the tuyers, but few cupolas are equipped with instruments to indicate the volume of air supplied. This latter really is more important than the pressure of the air, but a knowledge of both is desirable when operating a cupola. An instrument for indicating both the pressure and the volume of air has been devised for sale by the Bacharach Industrial Instrument Co., Pittsburgh.



VOLUME INDICATOR AND PRESSURE GAGE ARE ON THE SAME PANEL

This instrument consists of a pitot tube installed in the blast pipe and connected to the pressure and volume indicator as shown in the illustration. The pressure gage is the single tube type and is made V shape so as to be easily read. It is graduated to read inches of water. The volume indicator is an inclined tube gage, completely enclosed so as to be dust proof. It is filled with a liquid which will not freeze or evaporate. The scale is graduated to read in cubic feet of air delivered per minute. By means of the linked valves in the connections of the instrument, the zero of the indicator may be checked without breaking any of the connections.

The pitot tube is specially designed and has large openings to prevent clogging due to dust in the blast. It is stated provision is made for blowing out the tube with air or steam without breaking any connections.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

Plans are being drawn for the erection of a foundry for the Bayer Steam Soot Blower Co., St. Louis.

Plant improvements are contemplated by the Penobscot Foundry Co., Bangor, Me.

The Saginaw Malleable Iron Co., Saginaw, Mich., is building two plant additions.

The Plume & Atwood Mfg. Co., Thomaston, Conn., will build a 30 x 60-foot addition to its brass mill.

Erection of a plant addition is contemplated by the East Penn Foundry Co., Macungie, Pa.

The Trenton Malleable Iron Co., Trenton, N. J., plans plant improvements.

A foundry will be erected by the Iowa Steel & Iron Co., Cedar Rapids, Iowa.

The Dover Foundry & Mfg. Co., Boston, has awarded contracts for some plant improvements.

Erection of a core room, 1-story, 80 x 80 feet, is contemplated by the Atlas Foundry Co., Milwaukee.

Roy Fisher, Detroit, is president of the Fisher-Wilkie Foundry Co., which plans to erect a plant.

Part of the plant of the Richard Roberts & Son Foundry, Cardiff, Md., recently was damaged by fire.

The A-B Stove Co., Battle Creek, Mich., has increased its capital stock to $350,000, and will double the capacity of its foundry.

The Superior Mold & Equipment Co., Cuyahoga Falls, O., recently was incorporated with $50,000 capital, by A. G. Hachtel, S. J. Taylor and others.

Erection of a building to be devoted to the manufacture of foundry equipment, is contemplated by the Union Metal Mfg. Co., Canton, O.

Erection of a foundry, 32 x 60 feet, is contemplated by the North Buffalo Hardware Foundry Co., 743 Hertel avenue, Buffalo. Plans have been drawn.

The Canadian Car Wheel & Foundries Co., Montreal, Que., is reported planning to erect a plant at St. Boniface, Man.

Ground has been broken for the erection of a new shop and storage vault for the Adjax Pattern Co., 1016 Madison avenue, South Milwaukee, Wis.

The Peerless Foundry Co., Cincinnati, plans to increase its warehouse facilites. It has awarded a contract for the erecton of a building, 40 x 50 feet.

Erection of a plant with a capacity of 10 tons a day, will be started soon for the Midwest Castings Co., Middletown, O.

A permit has been taken out by the Lumen Bearing Co. for the erection of a foundry at Youngstown, O., to be 105 x 142 feet.

The Apex Brass Mfg. Co., Cleveland, recently was incorporated with $50,000 capital, by A. F. Counts, 911 American Trust building, J. H. Mellen and others.

The Percival Plow & Stone Co., Merrickville, Ont., is reported contemplating the erection of a plant addition.

A foundry, 2-stories, 50 x 100 feet, is being erected for the Harrison Square Foundry Co., Dorchester, Mass.

The plant of the C. M. Menefee Foundry Co., Ft. Wayne, Ind., has been purchased by the S. F. Bowser & Co., Inc. It is reported the new owner plans to double the capacity of the plant.

T. C. Crabbs, William K. Martin and John A. Johnson were named as the incorporators of the Crawfordsville Foundry Co., Crawfordsville, Ind., which was recently chartered with $60,000 capital.

Capitalized at $10,000, the Burns Pattern & Machine Co. recently was incorporated with headquarters at Detroit, by Herbert Hughes, Crosse Point Park, Mich., and others.

Nonferrous castings will be manufactured by the Rochester Machinery & Foundry Co., Rochester, N. Y., which was recently incorporated with $30,000 capital, by H. A. Chase and others.

Erection of a foundry, 82 x 222 feet, for the Crompton & Knowles Loom Works, Worcester, Mass., is progressing rapidly. The Alberthaw Construction Co., Boston, is in charge of building operations.

Contracts to erect an electric steel foundry for the Pettibone Mulliken Co., Chicago, have been awarded to Westinghouse, Church, Kerr & Co., New York.

Plans of the International Harvester Co., Chicago, to double the plant of its subsidiary, the Chattanooga Plow Co., Chattanooga, Tenn., recently were announced by the management of the company.

The Globe Metal Products Corp., Sheboygan, Wis., gray iron, brass and aluminum castings, recently increased its capitalization to finance the erection of a new foundry, now being constructed.

Contractors have started on the erection of a foundry building for Hinderer Bros. Co., Twentieth street and the Wheeling & Lake Erie railroad tracks, Canton, O.

Capitalized at $3000, the Beggs Foundry Co., Bessemer, Ala., recently filed articles of incorporation with the secretary of state. Incorporators include, J. P. Beggs and Oscar Cochranel.

The Marcus Hook Foundry Co., Marcus Hook, Pa., recently was incorporated with $50,000 capital, by M. W. Lefever and others. Plans of the company have not been made public.

The foundry at the plant of the Simons Leedle Furnace Co., Marshall, Mich., which is under lease by the Marshall Castings Co., is to be reopened and operated to capacity.

Harrows will be manufactured at Tarboro, N. C., by a $100,000 company which will be organized by M. G. Mann, T. T. Thomas and M. S. Brown, the first named to be president. The company will be known as the Eclipse Harrow Co.

The Ransome Canada Products Co., Ltd., Toronto, Ont., recently was incorporated with $10,000 capital to operate a foundry and machine shop. The incorporators are Thomas Gibson, J. G. Gibson and Ernest P. Seon.

Bernard C. Putnam, H. Monro Dunham and Eugene Jordan, all of Grand Rapids, Mich., recently incorporated the Welded Products Co., to engage in the manufacture of cast iron, bronze, etc. The company is capitalized at $100,000.

The Lucey Mfg. Co., Houston, Tex., is reported planning the erection of a plant to cost about $1,000,000 for the manufacture of oil well machinery and supplies. The establishment will include a gray iron foundry and forge shop, eight units in all.

Capitalized at $10,000 the West Brighton Brass Foundry, Inc., Richmond, N. Y., recently was incorpo-

rated by P. J. Knobloch, M. H. and M. Epstein, 721 Fulton street, Brooklyn, N. Y.

The Gartland-Carroll Foundry Co., Sandusky, O., is reported planning to double the capacity of its plant. According to the report, construction of the addition will be started in the spring.

Ground has been broken for the erection of a new plant for the Whitmore Machinery & Foundry Co., Menasha, Wis. The plant will be 60 x 116 feet, and will be equipped with an electric traveling crane and other modern equipment.

Plans have been drawn for the erection of a foundry for the Saco Lowell Works, Biddeford, Me.

Contracts have been awarded for the erection of a plant for the Terminal Pattern & Model Works, Newark, N. J.

Plans for the erection of a plant for the Towers & Sullivan Mfg. Co., Rome, Ga., manufacturer of plows, etc., as yet have not been fully developed, and information concerning the proposed plant additions is not available.

Contractors are erecting a warehouse and office building at the plant of Hillis & Sons, Ltd., 209-211 Hollis street, Halifax, N. S. When this work is completed, plans will be prepared for the erection of a foundry.

The Weber Dental Mfg. Co., Canton, O., is erecting two brick buildings each 33 x 80 feet. One will be used as an addition to the company's present brass and aluminum foundry and the other as an addition to the polishing and plating department.

The Dominion Bridge Co., Montreal, Que., will utilize the plant of the St. Lawrence Bridge Co., Rockfield, Que., for the manufacture of pulp and paper making machinery. The company also will build a gray iron foundry.

The Superior Brass Foundry Co., Milwaukee, which recently was incorporated with $50,000 capital by Philip Loeher, Frank Schedler and H. H. Wheeler, has taken over a shop building at 282 Lapham street, and is converting it into a brass casting shop.

Westinghouse, Church, Kerr & Co., have started construction of a portion of the plant, to comprise a gray iron foundry and other buildings, for the George D. Roper Co., Rockford, Ill., which took over the plant of the Eclipse Gas Stove Co.

The Connecticut Foundry Co., Rocky Hill, Conn., is making extensive additions to its plant, which will include a heating plant, extensions to the storage department, a pickling plant and additional cupola, capable of pouring 15 tons an hour.

Architects have completed plans for the erection of a plant for the Bryan Pattern & Machine Co., Bryan, O., to replace the plant recently damaged by fire. The building will be 50 x 250 feet. A new furnace building and administration building will also be erected.

The Maumee Malleable Castings Co., Detroit, has awarded contracts for the erection of plant additions to include a garage, 30 x 40 x 136 feet, a heat treating building, 90 x 200 feet, and a shipping and cleaning room, 120 x 180 feet. P. C. Jones is president of the company.

The Tilley Brass Mfg. Co., Los Angeles, manufacturer of brass, bronze and aluminum castings, has moved into larger quarters at 3420 South Main street, Los Angeles. Norman Tilley, manager, states that at the present time the company does not plan to erect a plant, but that the matter will be taken up in the future.

The Lanham Cotton Cultivator Co., Empire building, Atlanta, Ga., has completed plans for the erection of a plant, which will include a 2-story office building, 32 x 70 feet, machine and erecting shops, 75 x 140 feet, forge shop, 50 x 100 feet, foundry, 70 x 100 feet and other building. Construction of the plant is expected to be started shortly.

Work has been started on the erection of an addition to the plant of the Ross-Meehan Foundry Co. at Chattanooga, Tenn. The building will be used as an addition to the malleable iron unit, and is expected to increase the capacity of the department by 8000 tons a year, making the total capacity of the plant 20,000 tons.

The Western Malleables Co., Beaver Dam, Wis., is remodeling its Center street foundry. The annealing room is being enlarged and the pattern shop will undergo extensive changes to meet changed requirements. Much of the equipment will be replaced and greater capacity provided.

The Dane Machinery Co., Salem, Mass., recently was incorporated with $50,000 capital, to operate a foundry and machine shop, by J. W. Dane, F. L. Warner, John Little, C. and Joseph H. Poor of Danvers, Mass.

Plans have been completed for the erection of a foundry for the Mt. Vernon Foundry & Engineering Co., Mt. Vernon, O. The building will be 100 x 180 feet, of concrete and steel. It will be equipped with a large cupola. In addition to the main building a warehouse, 82 x 160 feet, for use as a pattern storage building, will be erected.

The Superior Steel Castings Co., Benton Harbor, Mich., plans the erection of an addition to be used as a malleable iron unit. The building will be 130 x 440 feet with wings, 60 x 80 and 60 x 100 feet. Construction will be started immediatley. W. R. Gilmore, vice president and general manager, who is in charge of construction, states the company is in the market for equipment for this unit.

Announcement recently was made by the Allis-Chalmers Mfg. Co., Milwaukee, that it has completed additions costing $3,600,000 to its main works at West Allis, Wis., and which will be devoted exclusively to the manufacture of farm tractors. The main tractor shop cost $3,000,000 and a foundry used for making castings for this purpose, represents an additional investment of $600,000.

The Metal Hose & Tubing Co., Raymond and Tillary streets, Brooklyn, N. Y., has had plans prepared for the erection of a plant addition and officials contemplate the expenditure of $50,000 for new equipment, none of which has been placed. A new power house will require two 150-horsepower return tubular boilers, feed water heaters, etc. New equipmnt will be installed in the machine shop, brass shop and brass foundry.

The Lancaster Structural & Foundry Works, Lancaster, Pa., recently was incorporated with $150,000, and has purchased the property of the Lancaster Machine & Structural Works. The plant is equipped with a gray iron foundry and a structural steel fabrication shop. Officers of the company are: President, J. M. Groff; vice president, J. T. Brennan; treasurer, Charles E. Long; engineer, W. Edward Lindsay and works manager, Edgar G. Hess.

New Trade Publications

CHEMICALS.—Under this title the New Jersey Zinc Co., New York, has published a booklet describing the various grades of sulphuric acid produced by the company, as well as muriatic acid, zinc chloride, salt cake, etc. The booklet contains an illustration of the company's general offices.

AIR HOISTS.—The Northern Engineering Works, Detroit, has published catalog No. 35, in which it describes and illustrates several types of vertical and horizontal air hoists. One type is equipped with a double beam socket bearing trolley, for use on cranes where head room is limited. Air jacks and air operated elevators are also described and illustrated in the booklet.

HANDLING EQUIPMENT.—Mechanical handling equipment of all kinds is described and illustrated in a booklet recently published by the Ohio Equipment Co., Cleveland. The equipment described includes lift trucks, steel truck platforms, shop mules, overhead carrying equipment, conveyors, tiering machines, crane scales, bundle tying machinery, etc. All are fully described and illustrated.

MONEL METAL.—An illustrated booklet, published by the Monel Metal Products Corp., Bayonne, N. J., describes and illustrates monel metal, an alloy of copper, nickel and other metals. According to the booklet, this metal can hardly be distinguished from pure nickel in color and in tensile properties it closely resembles steel. Various data are given in the booklet, including tables of physical properties, test, etc.

SAND-BLAST.—The Pangborn Corp., Hagerstown, Md., is circulating an interesting booklet, containing illustrations of the offices and various departments of its plants as well as illustrations of sand blast and other foundry equipment which it manufactures. The booklet is printed on heavy coated stock and the pictures are mounted on a background of blue. A list of users of the equipment manufactured by the company is given on the back page of the booklet.

FACTORY TRUCKS.—The use of trucks for the handling or storage of materials in the process of manufacture is described and illustrated in a 24-page booklet recently issued by the Howe Chain Co., Muskegon, Mich. These trucks consist of a platform, equipped with two malleable iron wheels at the rear and a malleable iron draw bar in front. Various types of bodies are provided for various work. The booklet contains a number of illustrations of these trucks in actual use and a list of users is given.

OIL BURNERS.—The Hauck Mfg. Co., Brooklyn, N. Y., recently published an illustrated 16-page booklet in which various types of oil burners and furnaces are described. According to the booklet they are used with excellent results in foundries, firing cupolas, drying molds, heating and drying ladles, patching cores, melting brass; in boiler shops laying up corners, shaping throat sheet work, flanging, dishing, heating rivets, bending pipe, etc.; in machine and repair shops, preheating for welding, brazing, expanding to make shrink fits, melting soft metals, tool dressing, tempering and heating soldering irons.

CLAM-SHELL BUCKETS.—An illustrated folder is being circulated by the Blaw-Knox Co., Pittsburgh, in which single line clam-shell buckets are described and illustrated. These buckets are made of riveted steel plate and parts are annealed open-hearth steel castings and heavy steel forgings. Renewable bushings are used and lubrication is provided by compression plugs, grease being forced into the cavities machined in the pins and castings. These buckets are adapted to various kinds of work in power plants, foundries, steel mills, on railroad construction work, etc.

REFRACTORY BRICK.—A booklet of 16 pages has been published by the Harbison-Walker Refractories Co., Pittsburgh, in which refractory brick especially adapted for service in open hearth and electric furnaces are described and illustrated. This brick was first placed on the market in 1916. For general use the brick consist of round or square soft steel containers, open at the ends, and packed with ground dead-burned magnesite. According to the booklet they are especially adapted for service in the back-walls, bulkheads and ends of the basic open-hearth furnace, and the sidewalls of the electric furnace. Other data are given and the illustrations show the use of the brick.

PREHEATER.—A 14-page loose leaf booklet has been issued by the Geist Mfg. Co., Atlantic City, N. J., in which a general continuous metal heating medium is described and illustrated. The preheater is square in shape with a large flat table-like surface. The top consists of heavy metal grating between the bars of which is placed a special heat-absorbing element, which absorbs the heat furnished by a series of burners. These burners are placed in rows, running from the sides to the center and each is controlled by its own valve. A cooling oven is located beneath the burners. It is stated this oven retains a heat ranging downward from 500 degrees Fahr., is free of all draught, and reduces the heat of the finished piece with a slow even contracton. Other parts of the preheater are described.